

FIG. 1

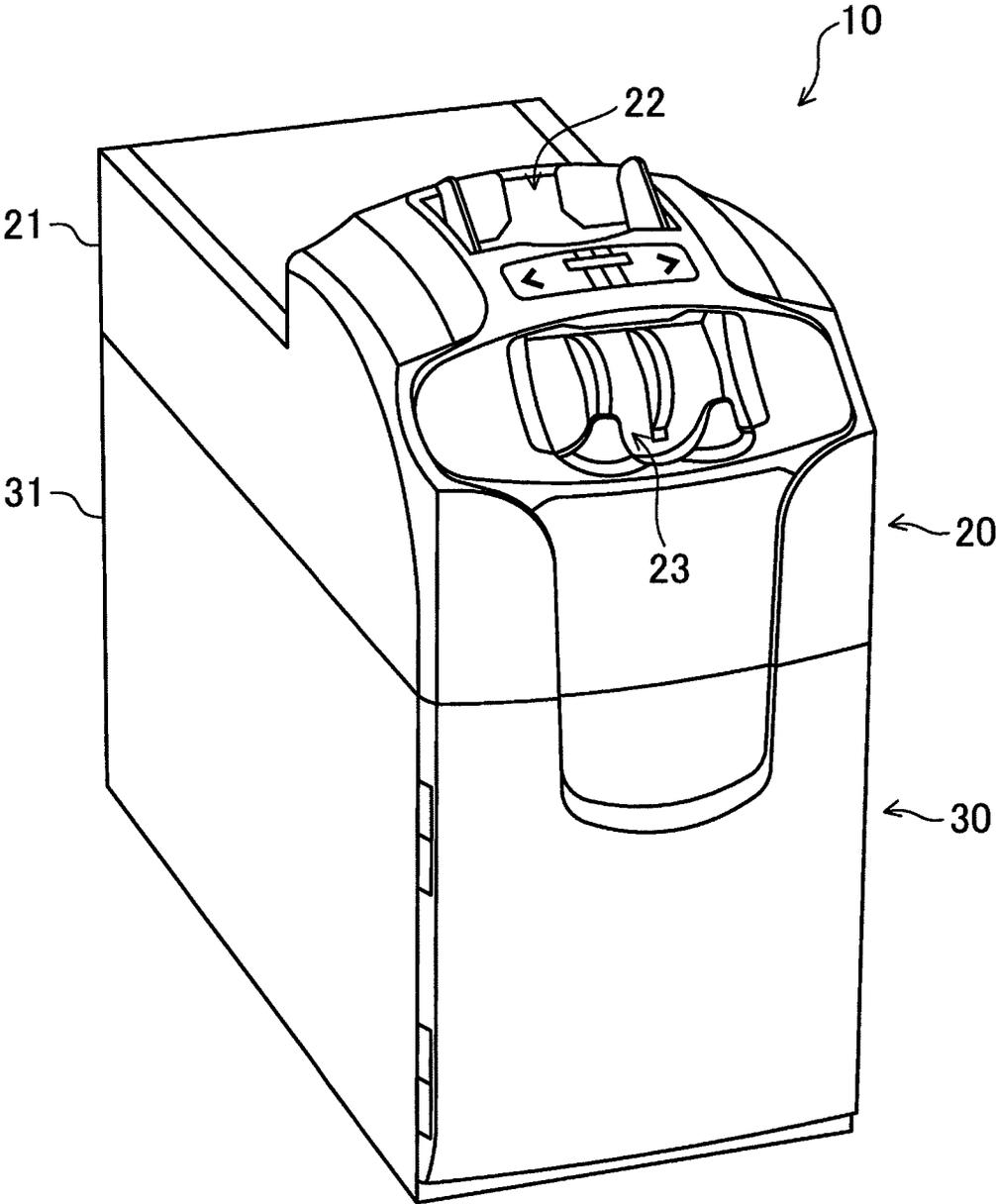


FIG. 2

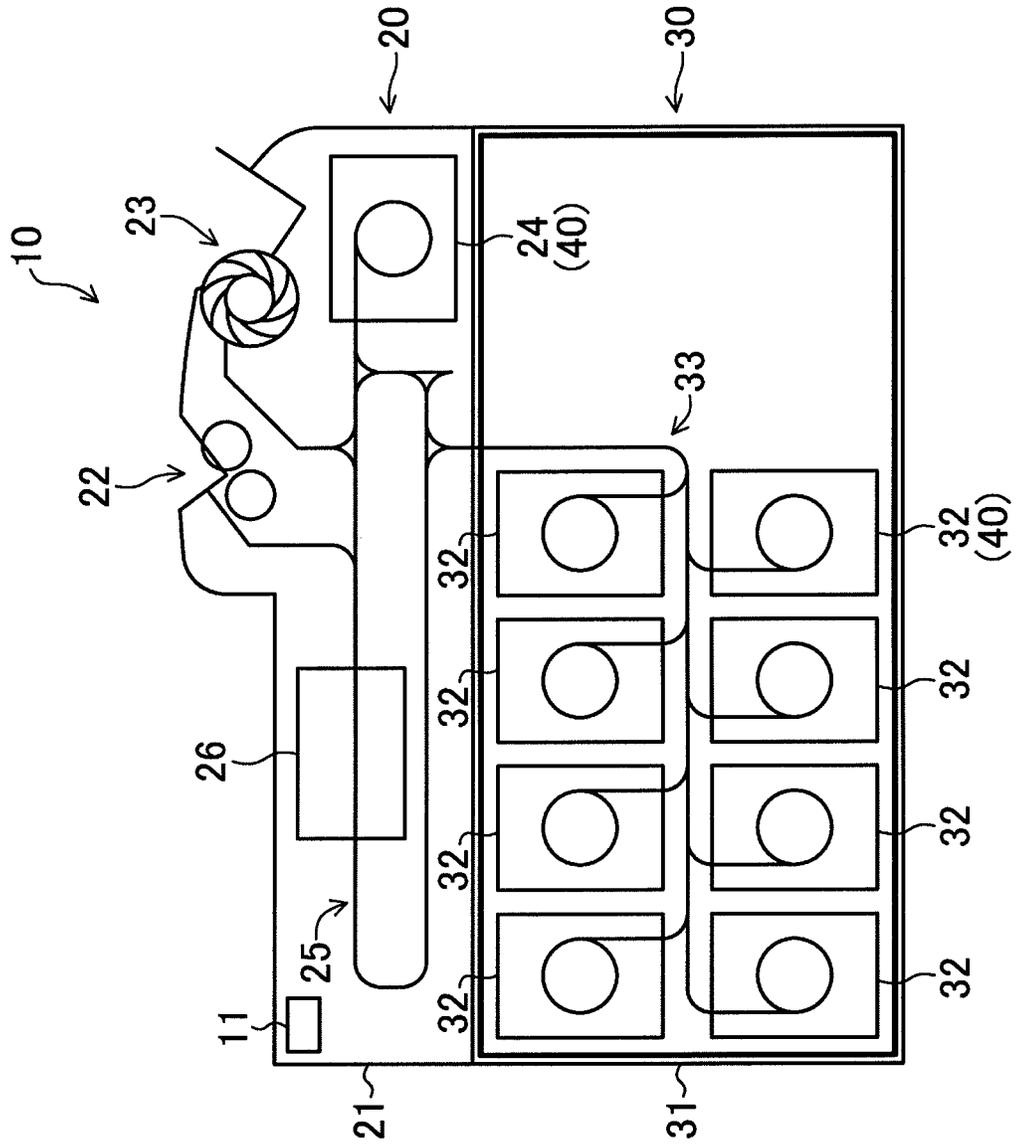


FIG. 3

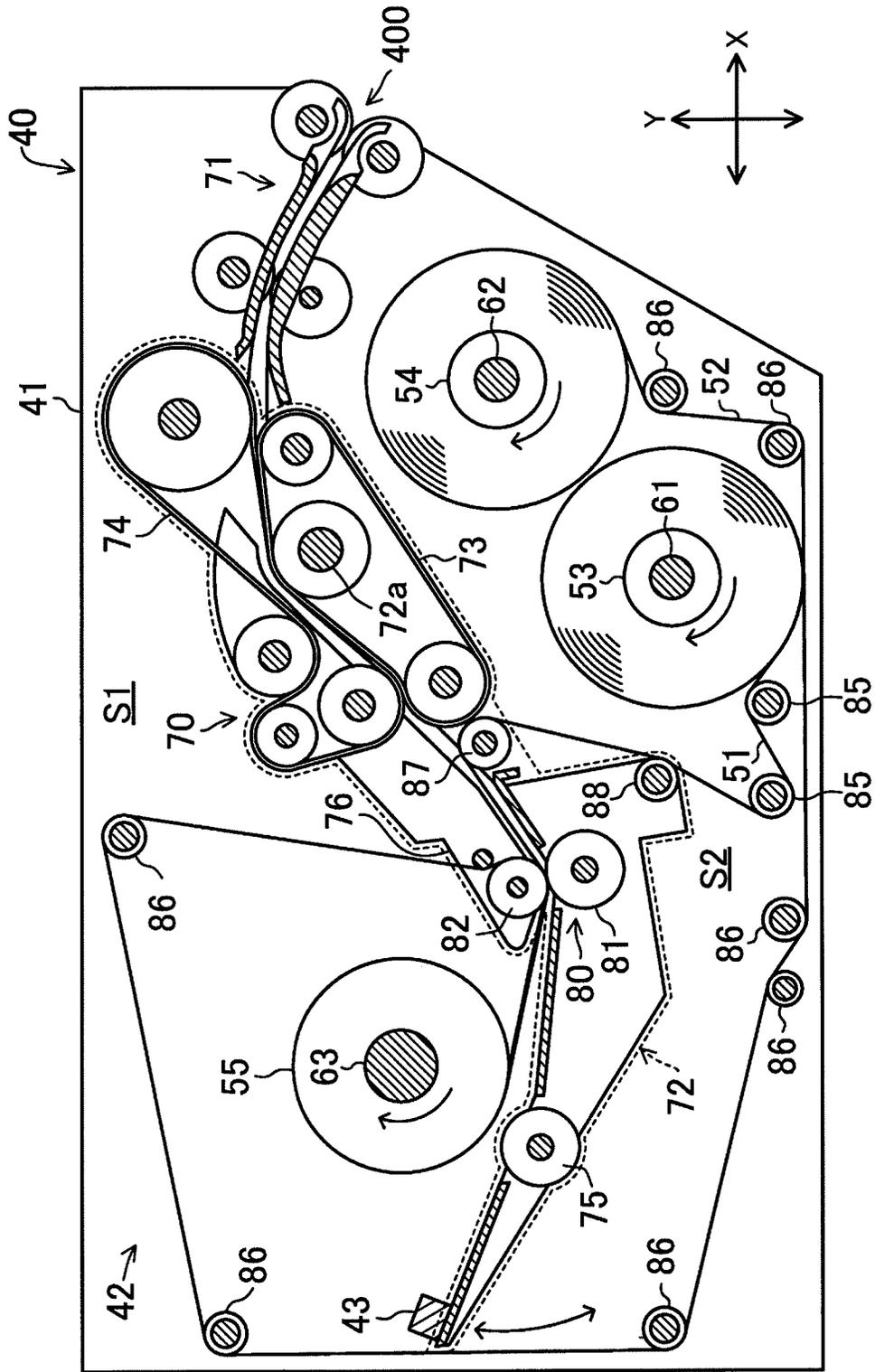


FIG.4

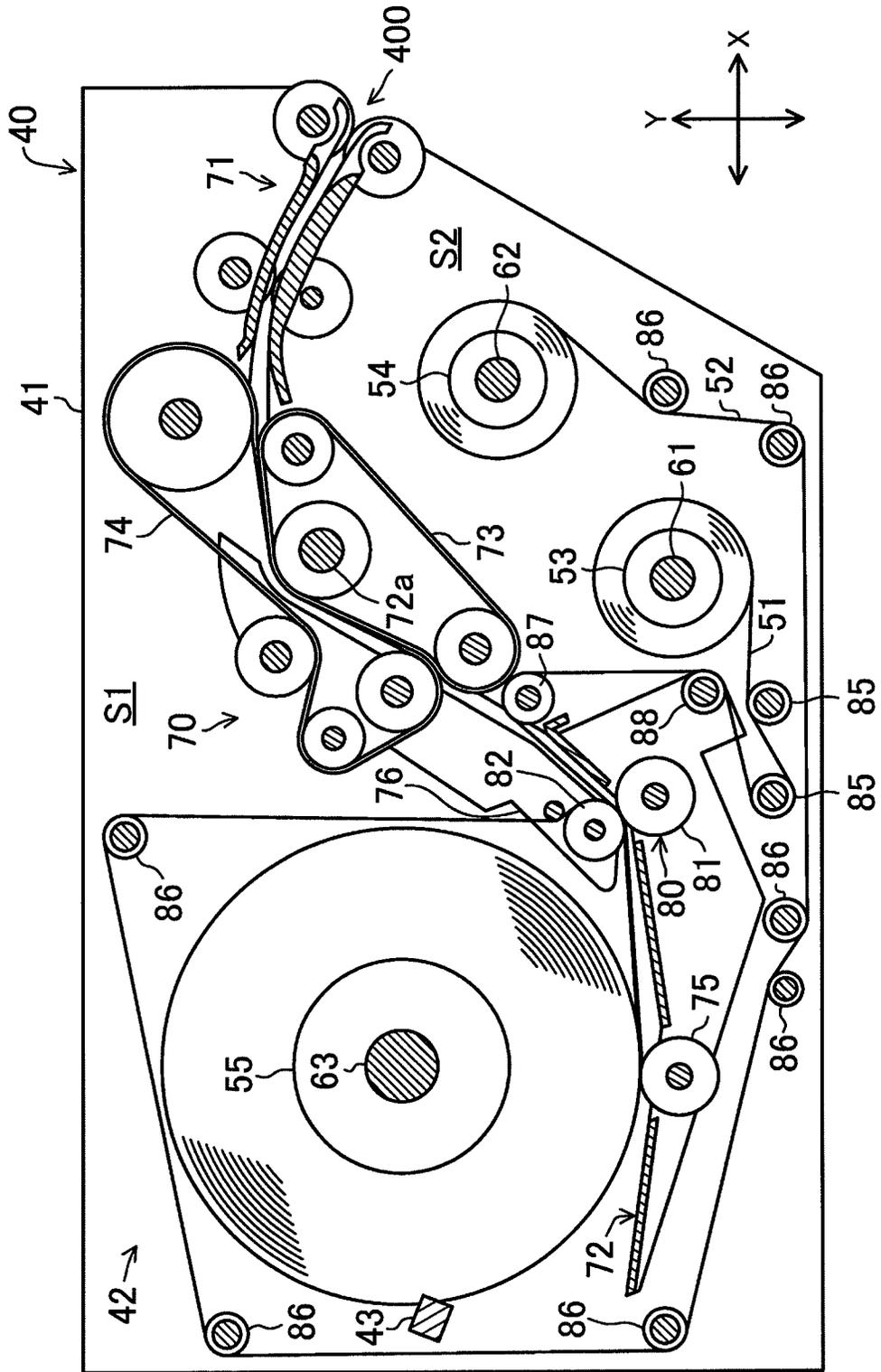


FIG. 5

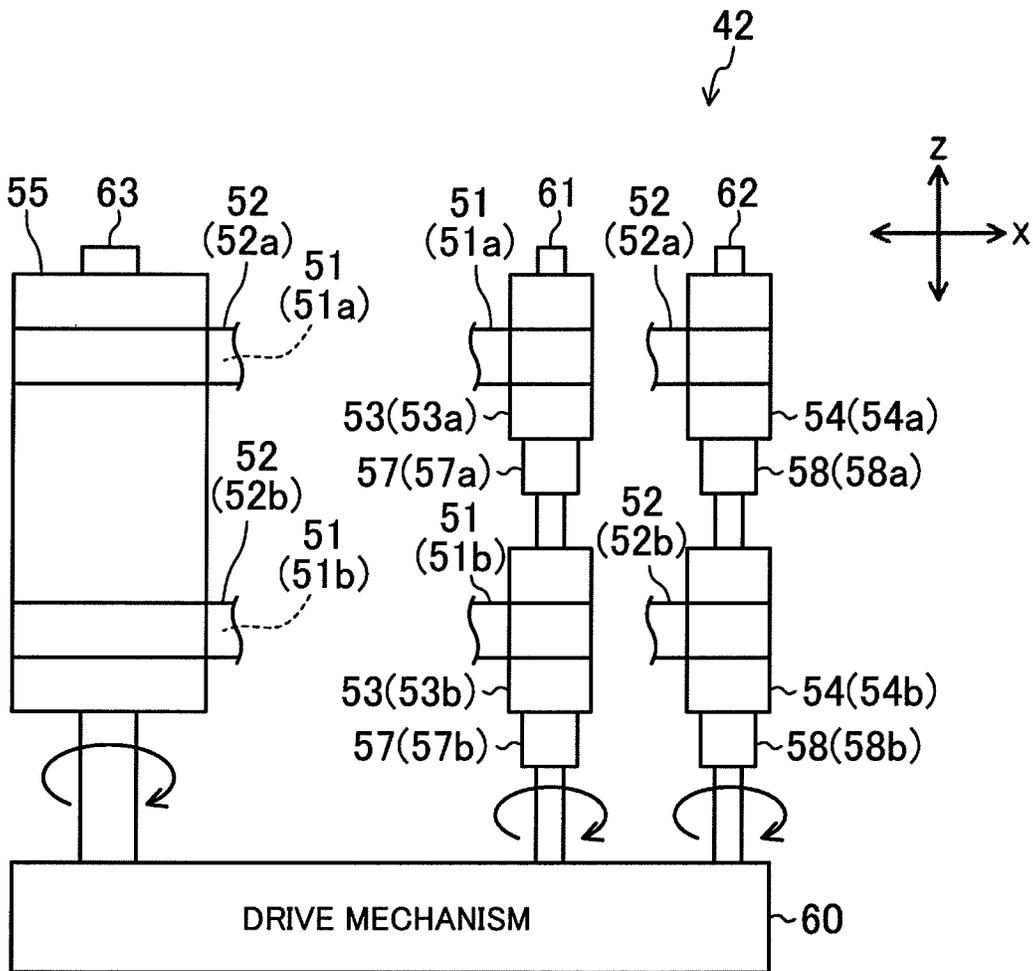


FIG.6

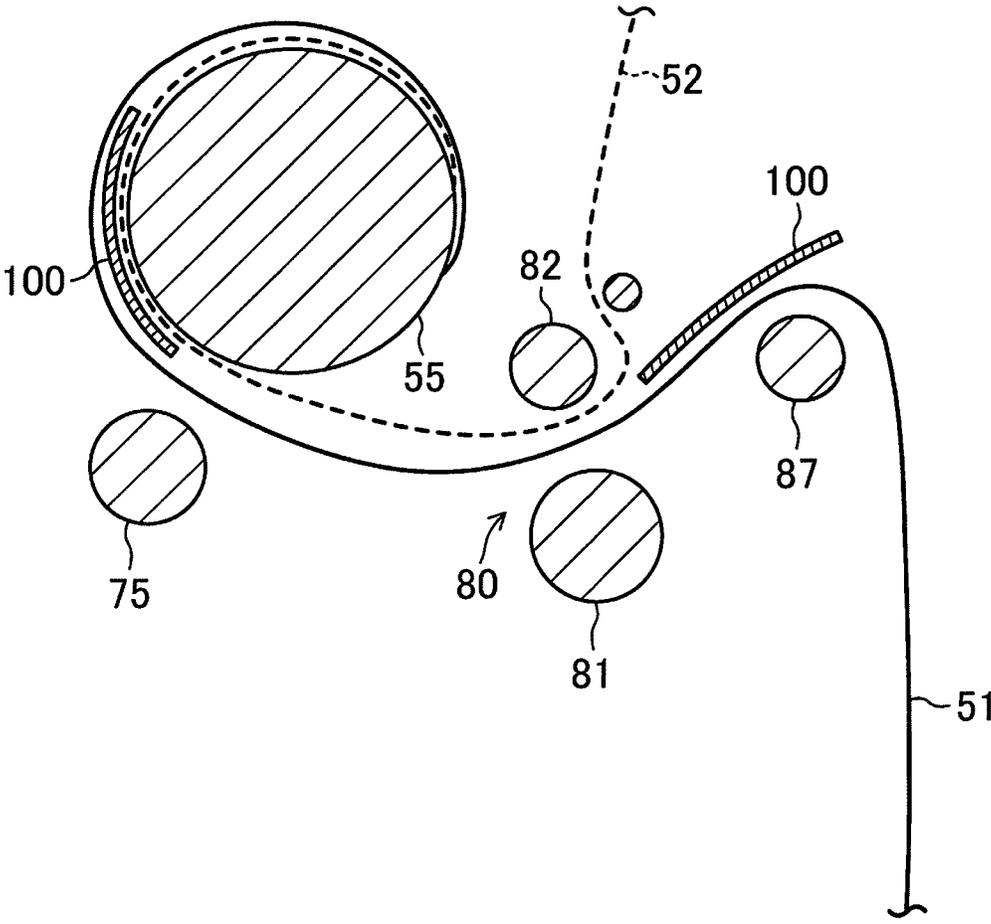


FIG. 7

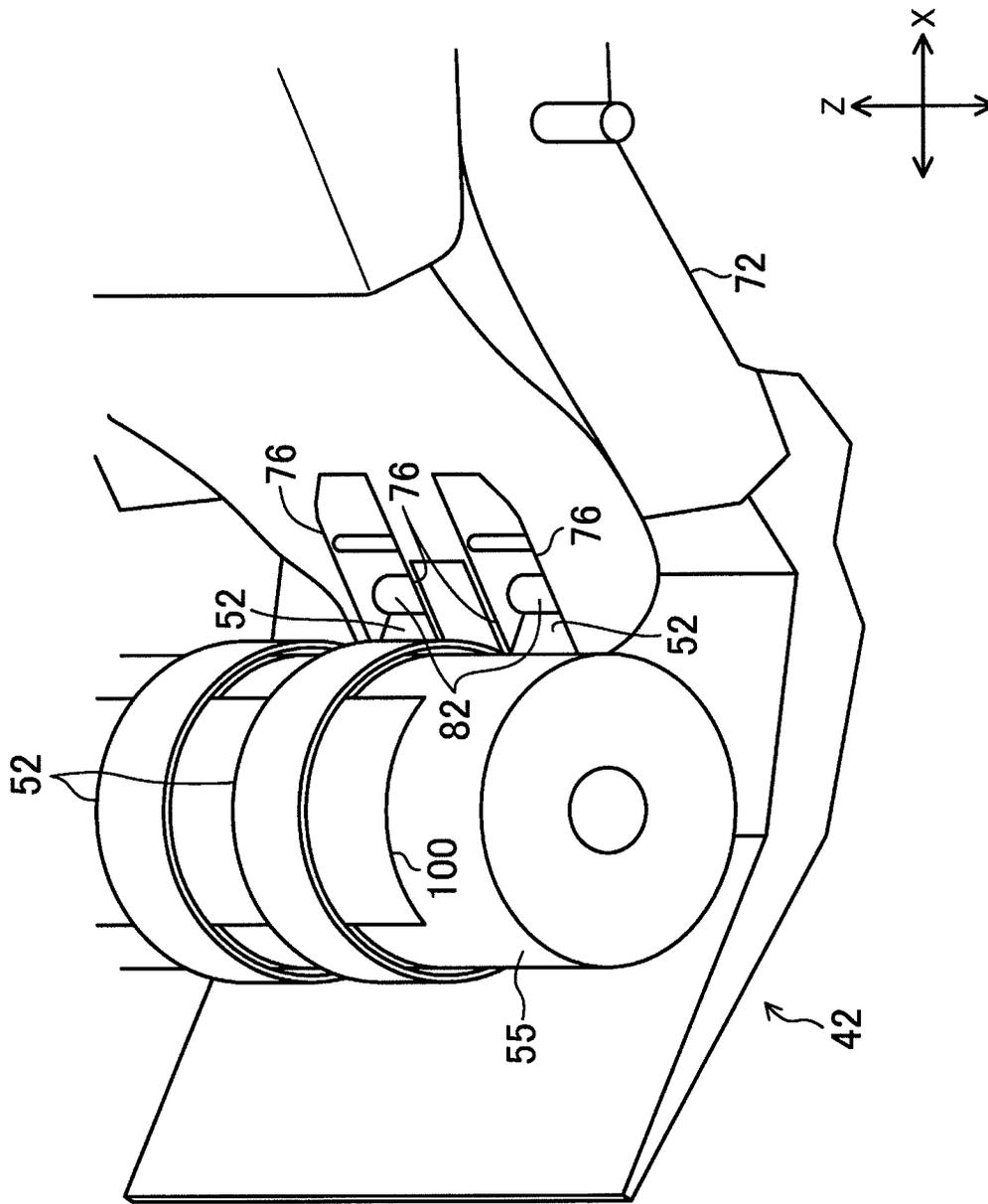


FIG. 8

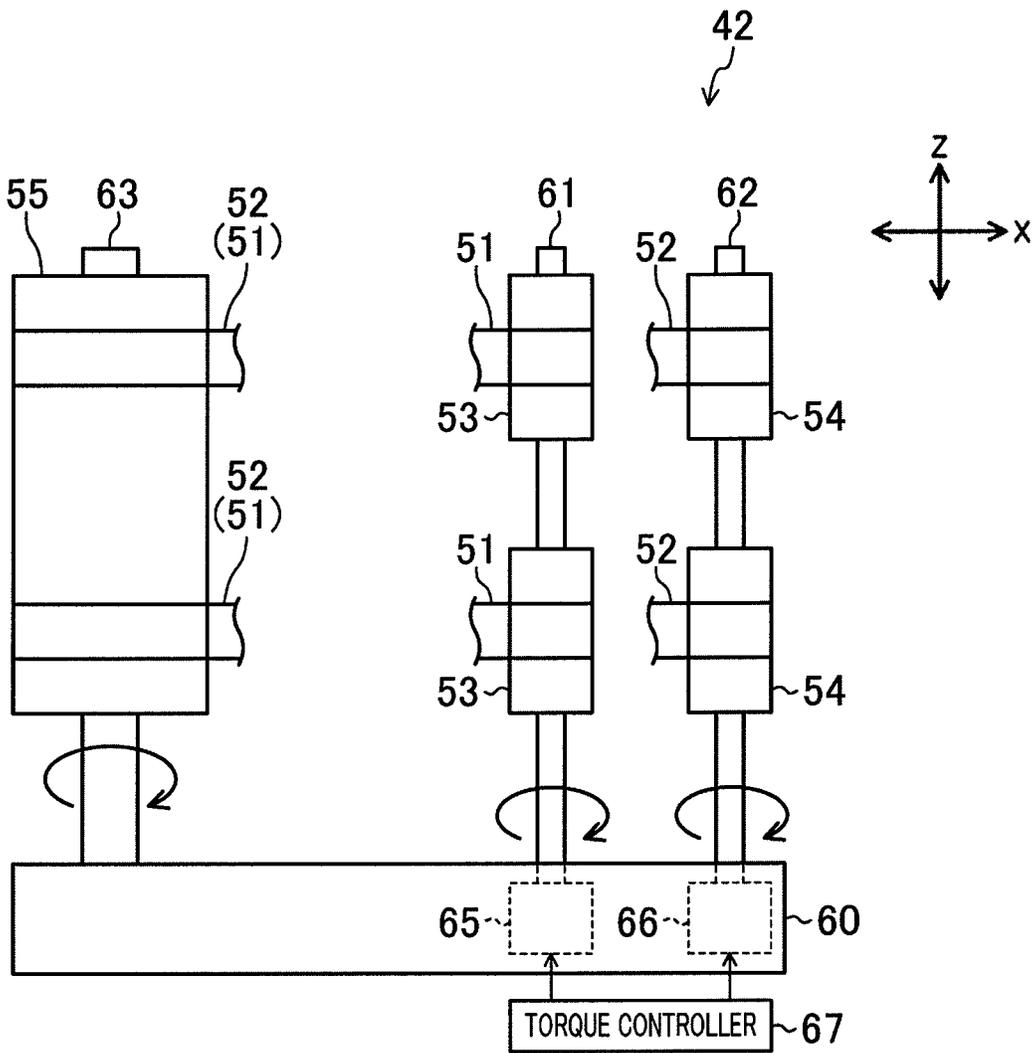


FIG. 9

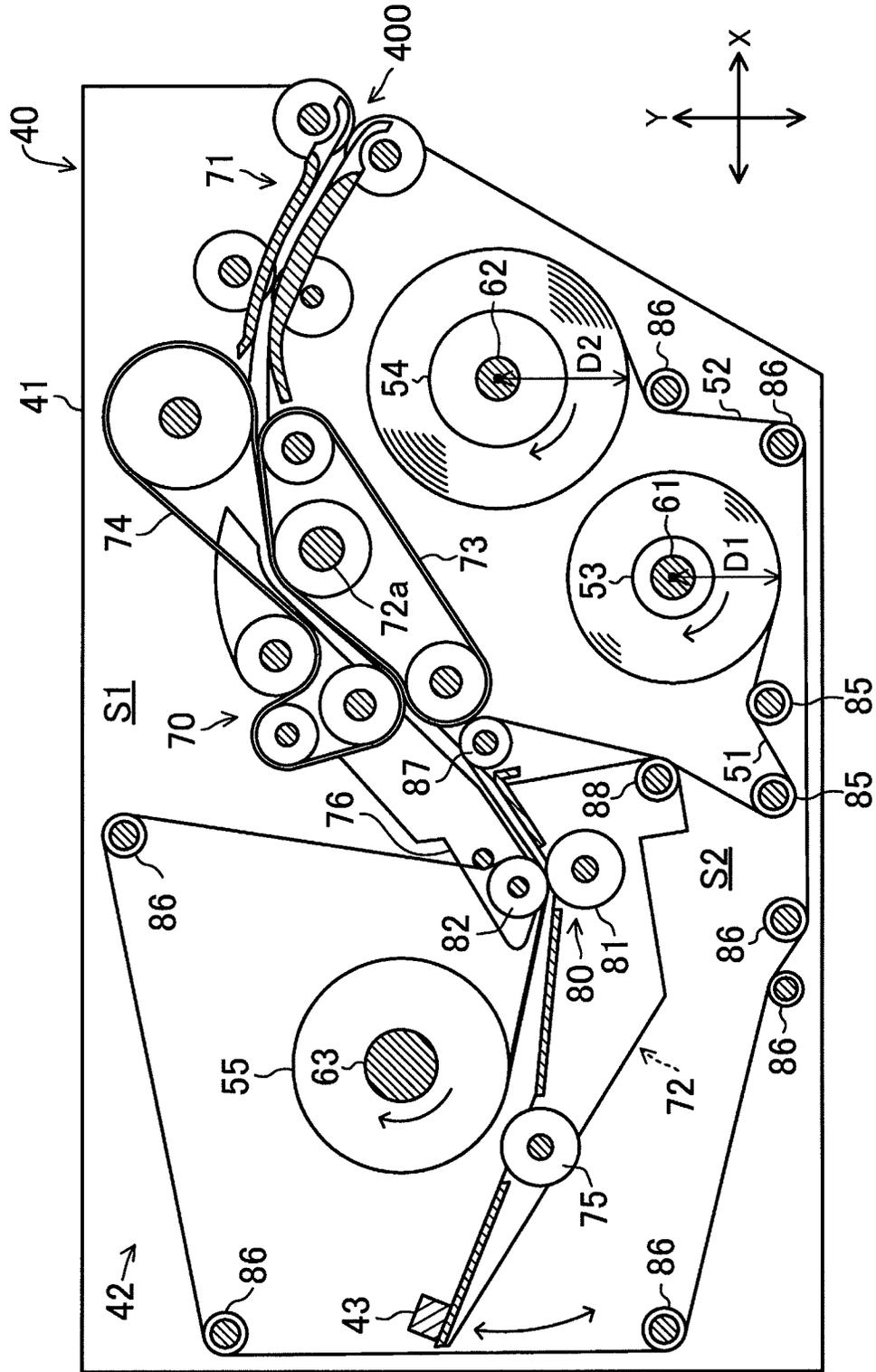


FIG.10

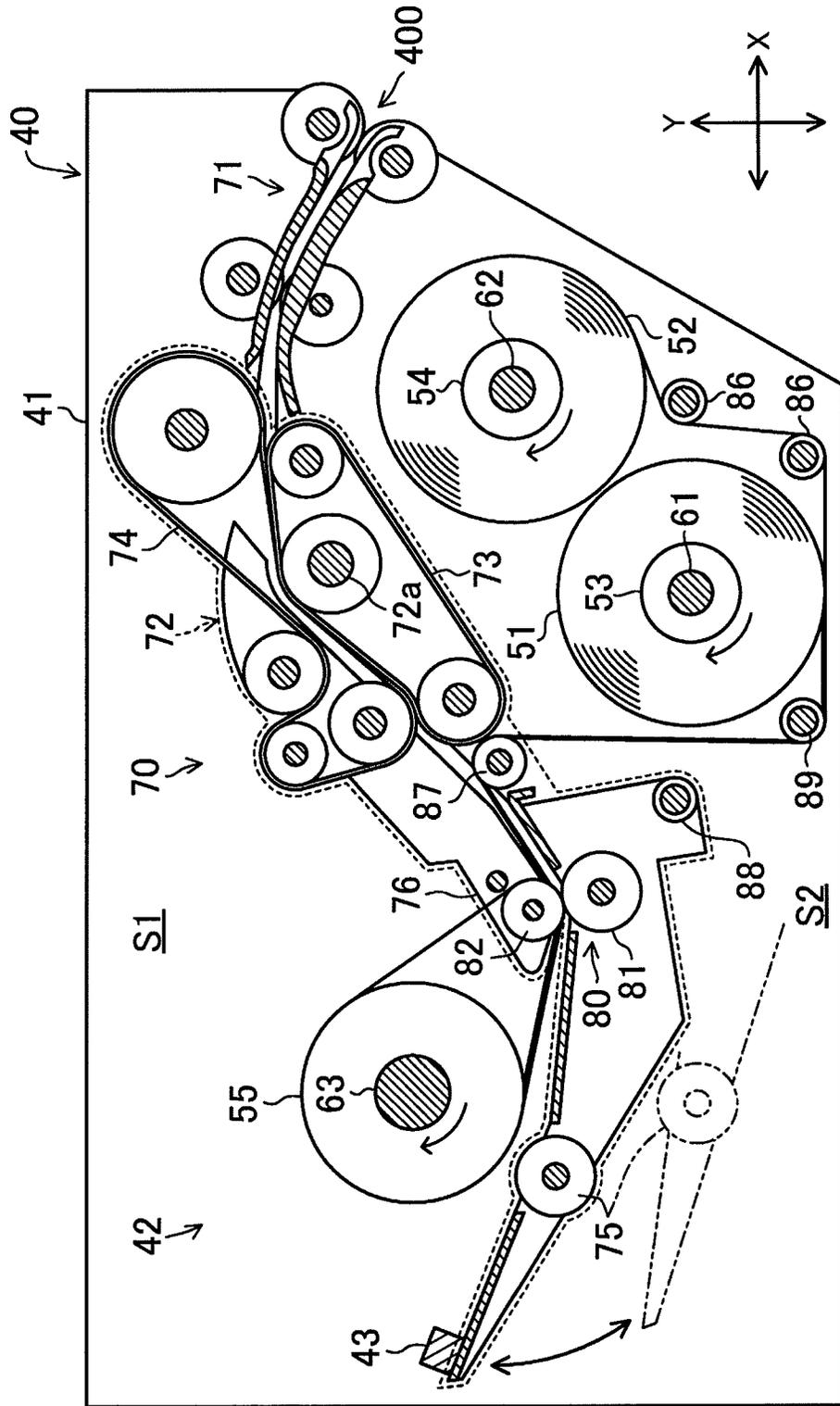


FIG.11

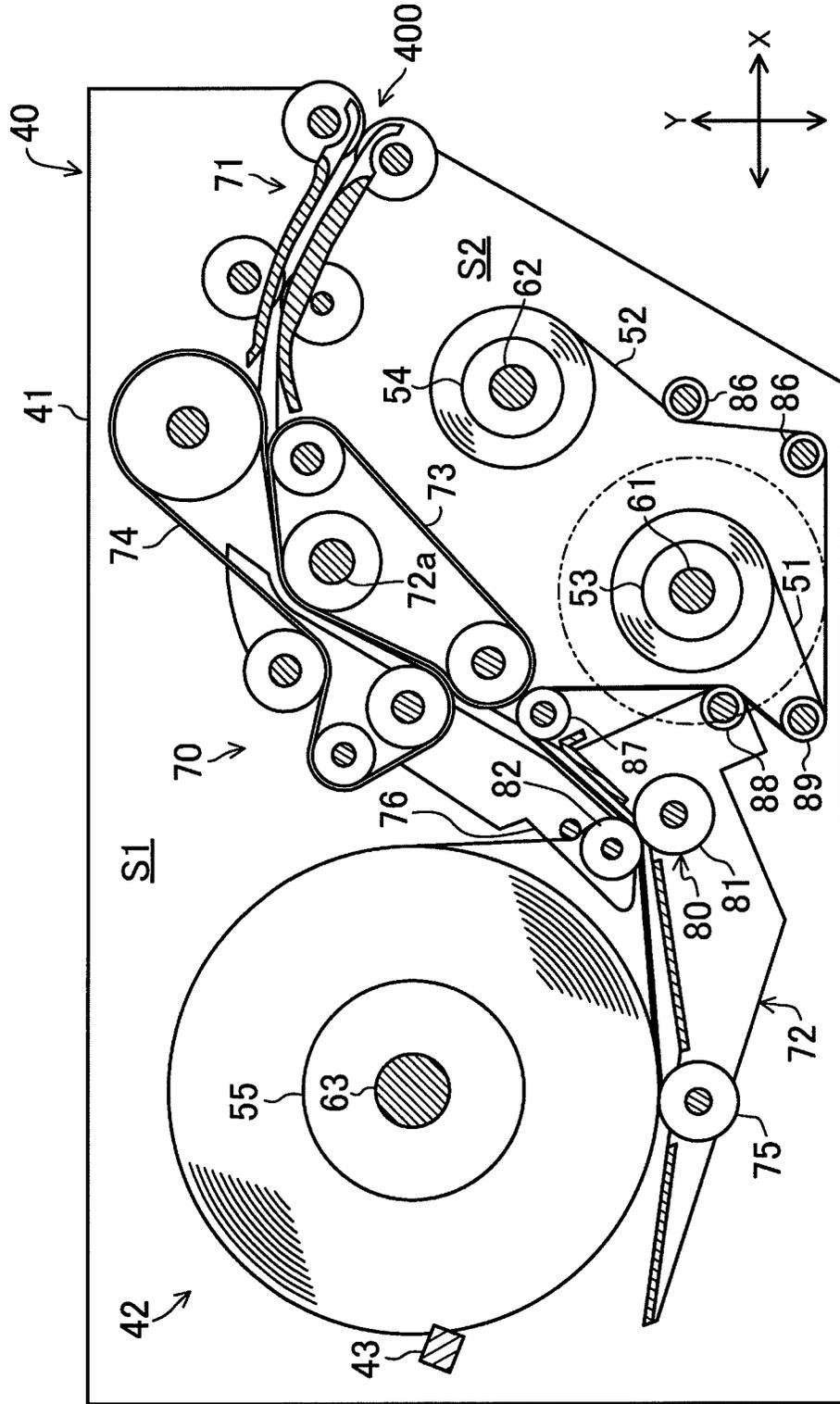


FIG.12

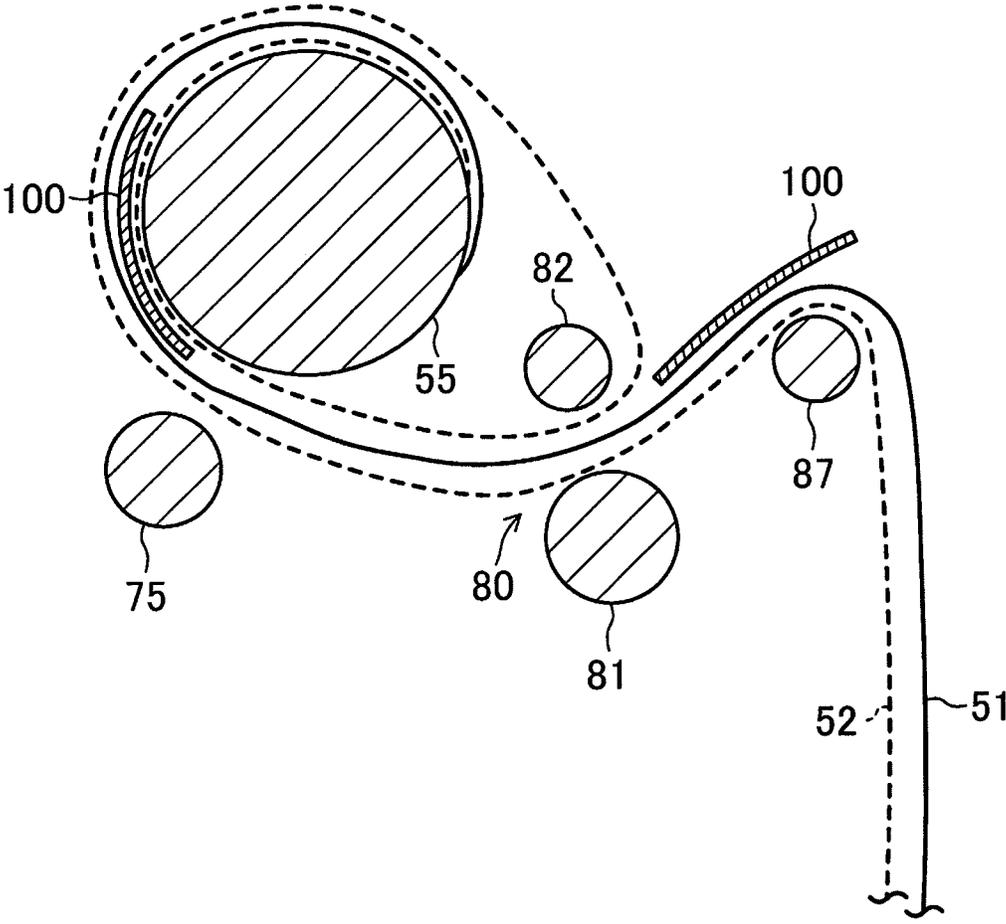


FIG. 13

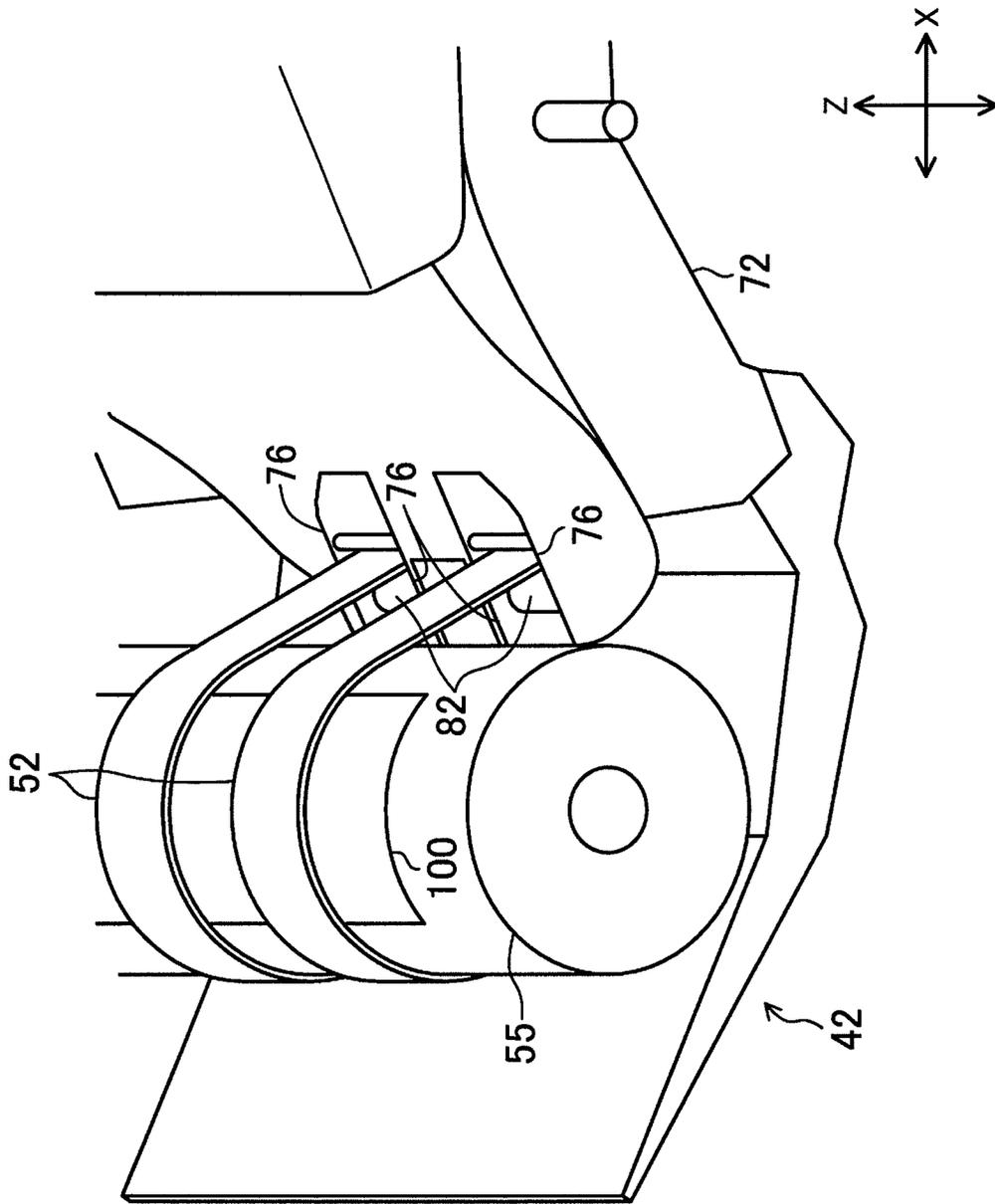
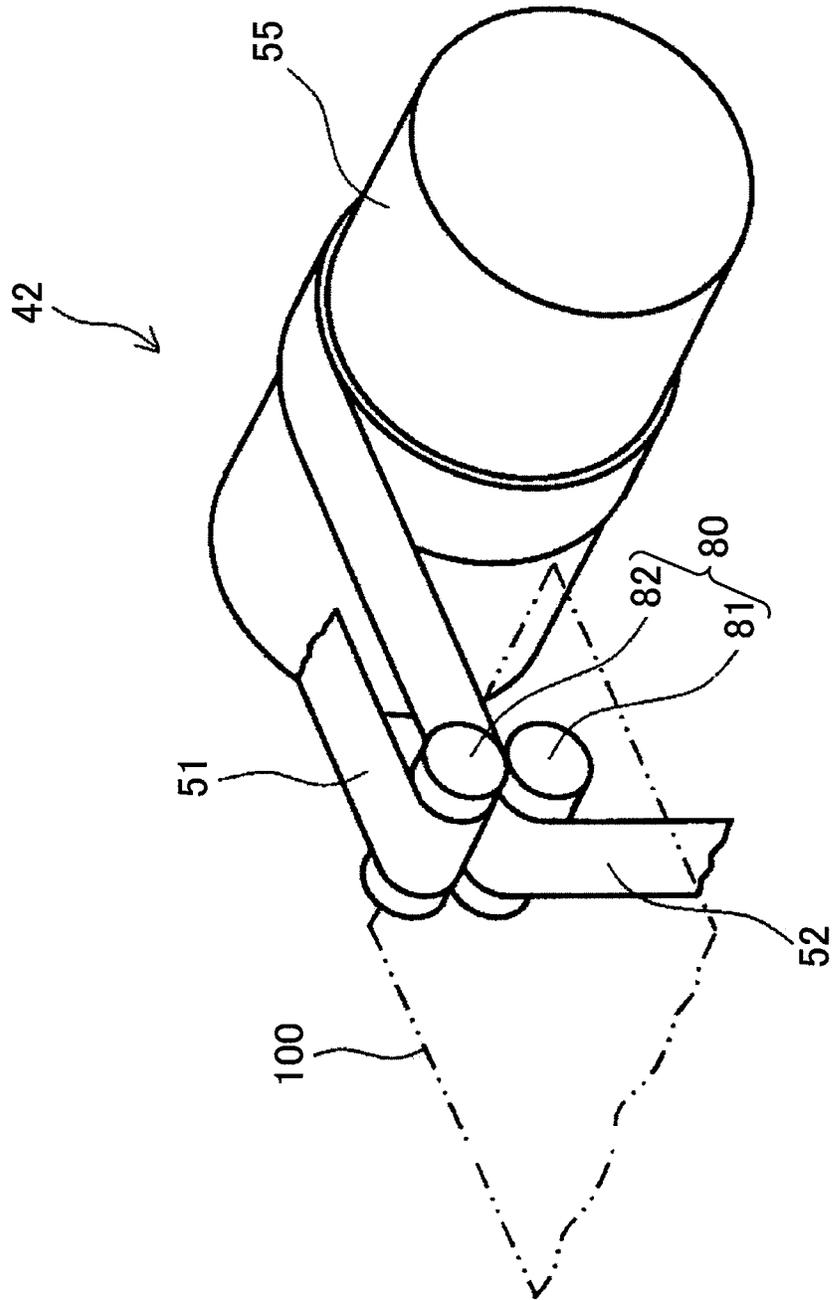


FIG.14



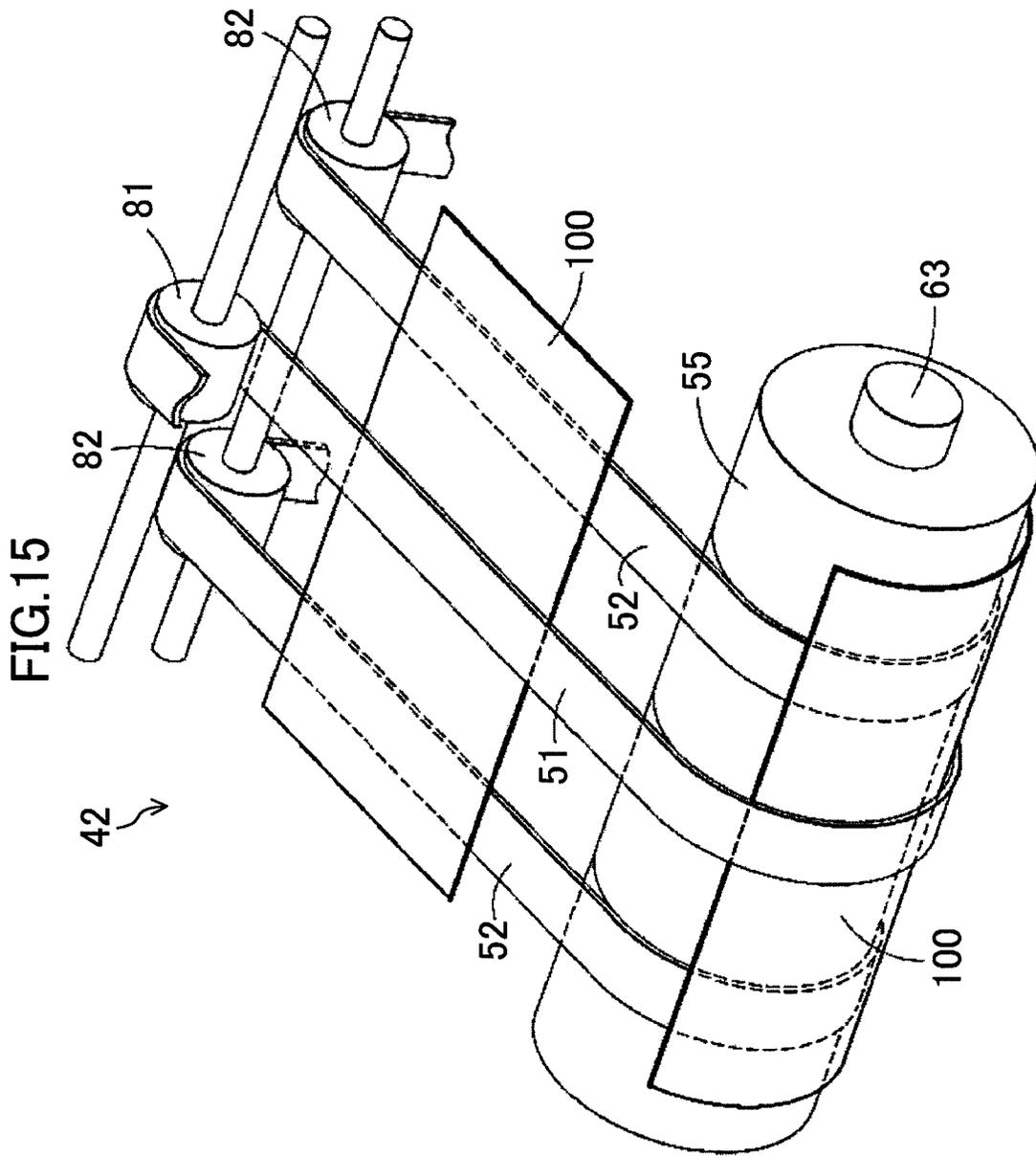


FIG.16

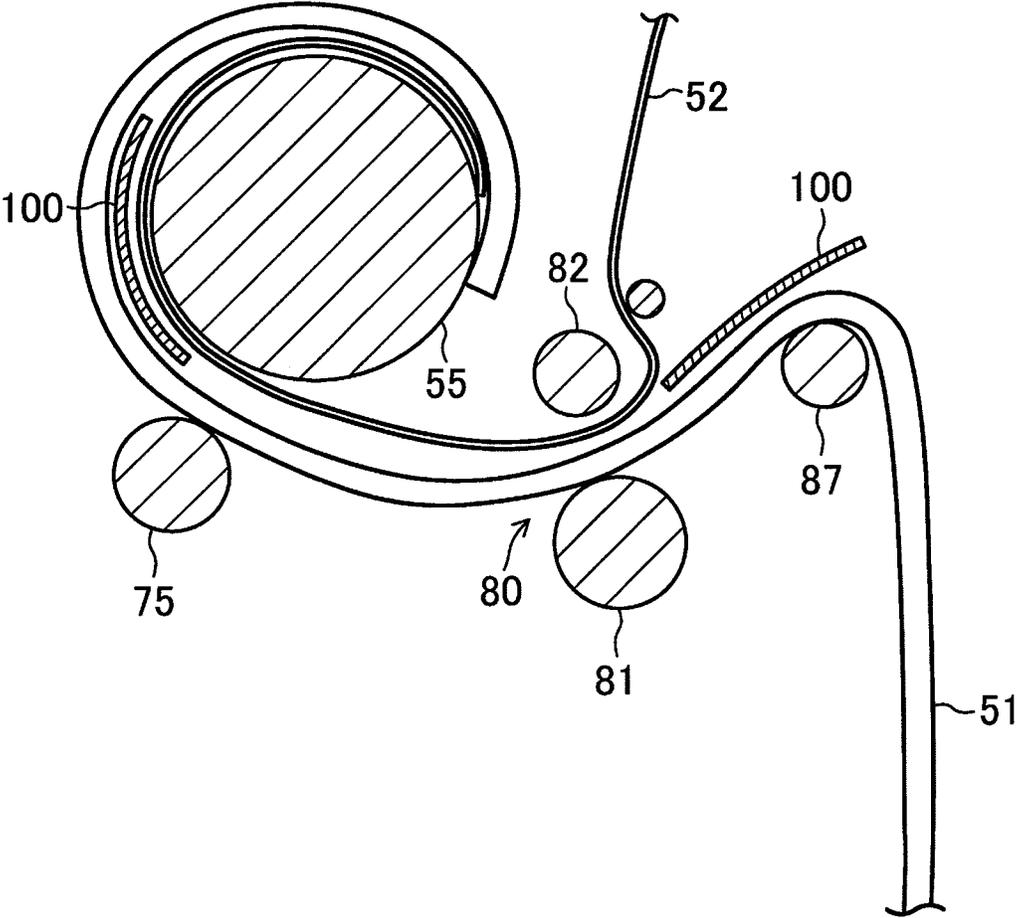


FIG.17

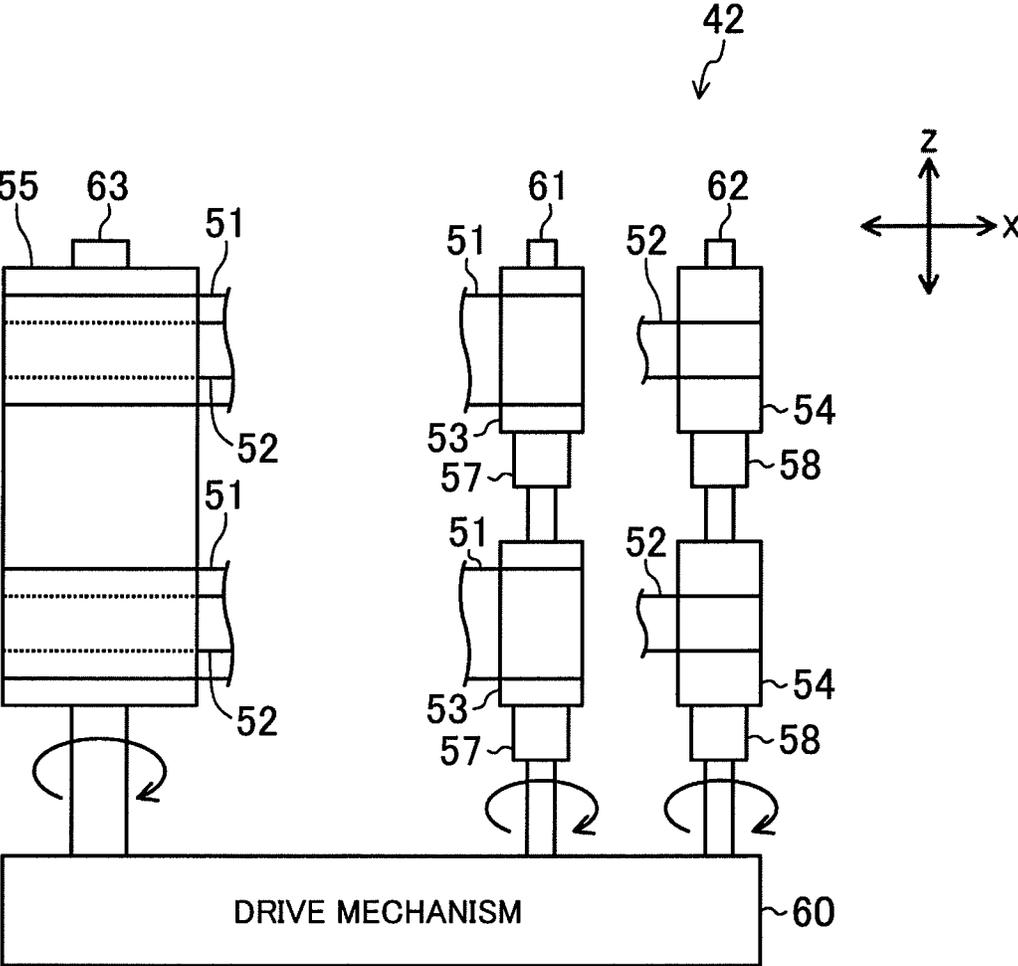


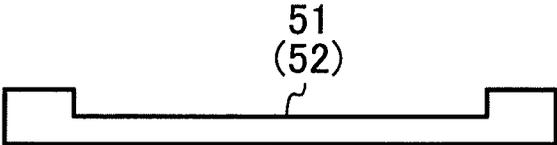
FIG.18



FIG.19



FIG.20



**PAPER SHEET STORAGE DEVICE AND
PAPER SHEET HANDLING MACHINE****CROSS-REFERENCE TO RELATED
APPLICATION**

This application claims priority to Japanese Patent Application No. 2018-058341 filed on Mar. 26, 2018, the entire disclosure of which is incorporated by reference herein.

BACKGROUND

Japanese Unexamined Patent Publication No. 2013-199365 discloses a medium storage and feeding device that stores or feeds a medium by winding or rewinding a pair of tapes with the medium held between tape reels and a drum. The medium storage and feeding device includes a plurality of sets of tapes, a plurality of sets of tape reels that respectively wind up the plurality of sets of tapes, two reel rotation axle shafts that are rotation axles of the tape reels and are separately provided for one tape reel and another tape reel of the respective sets, a drum that winds the medium nipped by the plurality of sets of tapes together with the plurality of sets of tapes, and torque controllers that are independently provided at each of the tape reels and that control torques between the tape reels and the reel axle shafts such that tensions on the tapes between the tape reels and the drum are constant.

SUMMARY

However, according to Japanese Unexamined Patent Publication No. 2013-199365, the tension acting on each of the two tapes wound around the drum with the paper sheets sandwiched therebetween may not be kept constant at all times due to uneven performance of the torque controllers, uneven shape or strength of the tapes, and/or difference in reel winding diameters. In particular, when one of the tapes, which are wound around the drum with the paper sheets sandwiched therebetween, positioned outside the paper sheets in the radial direction of the drum receives a smaller tension than the other tape positioned inside the paper sheets in the radial direction of the drum, the tape positioned outside the paper sheets in the radial direction of the drum is easily loosened. This may easily deteriorate the winding state of the paper sheets on the drum.

In view of the foregoing, an object of the present disclosure is to provide a paper sheet storage device capable of reducing the deterioration of the winding state of paper sheets on a drum.

The present disclosure relates to a paper sheet storage device performing a storage operation of storing a paper sheet sent into the device and a feeding operation of feeding the paper sheet. The paper sheet storage device includes: a first tape; a second tape; a first reel configured to wind the first tape from one end of the first tape; a second reel configured to wind the second tape from one end of the second tape; and a drum configured to wind the first tape and the second tape from other ends of the first tape and the second tape. In the storage operation, the first tape and the second tape are wound around the drum with the paper sheet sandwiched therebetween to store the paper sheet, the first tape being positioned outside the paper sheet in a radial direction of the drum. In the feeding operation, the first tape is wound around the first reel and the second tape is wound around the second reel to feed the paper sheet from the drum.

In at least one of the storage operation or the feeding operation, greater tension acts on the first tape than on the second tape.

In this configuration, in the storage operation (or the feeding operation), the tension acting on the first tape is made greater than that acting on the second tape. Thus, when the first and second tapes are wound around the drum with the paper sheet sandwiched therebetween, the first tape positioned outside the paper sheet in the radial direction of the drum can be tightly wound around the drum. This can make the first tape less loosened in the storage operation (or the feeding operation), and can reduce the deterioration of a winding state of the paper sheet on the drum.

The paper sheet storage device may include a torque controller which controls a torque acting on the first reel and a torque acting on the second reel.

In this configuration, controlling the torque acting on the first reel can control the tension acting on the first tape, and controlling the torque acting on the second reel can control the tension acting on the second tape.

The torque controller may include a first torque limiter which regulates the torque acting on the first reel and a second torque limiter which regulates the torque acting on the second reel. The maximum torque of the first reel regulated by the first torque limiter is greater than the maximum torque of the second reel regulated by the second torque limiter.

In this configuration, the maximum torque of the first reel is greater than that of the second reel. As the torque acting on the first reel increases, the tension acting on the first tape tends to increase. Likewise, as the torque acting on the second reel increases, the tension acting on the second tape tends to increase. Consequently, when the maximum torque of the first reel is made greater than that of the second reel, the tension acting on the first tape can be made greater than that acting on the second tape. This can make the first tape less loosened, and can reduce the deterioration of the winding state of the paper sheet on the drum.

The paper sheet storage device may include a first driver which rotationally drives the first reel, and a second driver which rotationally drives the second reel. In at least one of the storage operation or the feeding operation, the torque controller controls the first driver and the second driver such that the torque acting on the first reel when the first driver rotationally drives the first reel is greater than the torque acting on the second reel when the second driver rotationally drives the second reel.

In this configuration, the first driver and the second driver are controlled, so that the tension acting on the first tape can be made greater than that acting on the second tape in the storage operation (or the feeding operation). Thus, the first tape can be wound more tightly around the drum than the second tape, thereby making the first tape less loosened in the storage operation (or the feeding operation). This can reduce the deterioration of the winding state of the paper sheet on the drum.

A winding diameter of the first tape on the first reel is smaller than a winding diameter of the second tape on the second reel.

In this configuration, the winding diameter of the first tape on the first reel is smaller than that of the second tape on the second reel. As the winding diameter of the first tape on the first reel decreases, the tension acting on the first tape tends to increase. Likewise, as the winding diameter of the second tape on the second reel decreases, the tension acting on the second tape tends to increase. Consequently, when the winding diameter of the first tape on the first reel is made

smaller than that of the second tape on the second reel, the tension acting on the first tape can be made greater than that acting on the second tape. This can make the first tape less loosened, and can reduce the deterioration of the winding state of the paper sheet on the drum.

The first tape may be thicker than the second tape.

In this configuration, the first tape is made thicker than the second tape, thereby improving durability of the first tape against the tension. This can reduce the deterioration of the first tape due to the tension. Furthermore, the strength of the first tape against reaction force of the paper sheet sandwiched between the first tape and the second tape can be improved, and the paper sheet can be tightly wound around the drum by the first tape. This can reduce the deterioration of the winding state of the paper sheet on the drum. Furthermore, when the second tape is made thinner than the first tape, the apparent radius of the drum can be reduced.

The first tape may be wider than the second tape.

In this configuration, the first tape is made wider than the second tape, thereby improving durability of the first tape against the tension. This can reduce the deterioration of the first tape due to the tension. Furthermore, a contact area between the first tape and the paper sheet can be increased, and the paper sheet can be tightly wound around the drum by the first tape. This can reduce the deterioration of the winding state of the paper sheet on the drum.

The First Tape may have Higher Rigidity than the Second Tape.

In this configuration, the first tape is provided with higher rigidity than the second tape, thereby improving durability of the first tape against the tension. This can reduce the deterioration of the first tape due to the tension. Furthermore, the strength of the first tape against the reaction force of the paper sheet sandwiched between the first tape and the second tape can be improved, and the paper sheet can be tightly wound around the drum by the first tape. This can reduce the deterioration of the winding state of the paper sheet on the drum.

The first and second tapes may be wound around the drum to overlap with each other in the radial direction of the drum.

The first and second tapes may be wound around the drum not to overlap each other in the radial direction of the drum.

The present disclosure relates to a paper sheet handling machine, and the paper sheet handling machine includes the paper sheet storage device described above.

In this configuration, since the deterioration of the winding state of the paper sheet on the drum can be reduced, the frequency of pause of the paper sheet handling machine caused by a winding failure of the paper sheet in the paper sheet storage device can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic perspective view illustrating an external appearance of a paper sheet handling machine.

FIG. 2 is a schematic view illustrating an internal configuration of the paper sheet handling machine.

FIG. 3 is a schematic sectional view illustrating a configuration of the paper sheet storage device.

FIG. 4 is a schematic sectional view illustrating a configuration of the paper sheet storage device.

FIG. 5 is a schematic plan view illustrating a major part of the paper sheet storage device.

FIG. 6 is a conceptual view illustrating a major part of the paper sheet storage device.

FIG. 7 is a schematic perspective view illustrating a major part of the paper sheet storage device.

FIG. 8 is a schematic plan view illustrating a first modification of the paper sheet storage device.

FIG. 9 is a schematic sectional view illustrating a second modification of the paper sheet storage device.

FIG. 10 is a schematic sectional view illustrating a third modification of the paper sheet storage device.

FIG. 11 is a schematic sectional view illustrating the third modification of the paper sheet storage device.

FIG. 12 is a conceptual view illustrating a major part of the third modification of the paper sheet storage device.

FIG. 13 is a schematic perspective view illustrating a major part of the third modification of the paper sheet storage device.

FIG. 14 is a schematic perspective view illustrating a fourth modification of the paper sheet storage device.

FIG. 15 is a schematic perspective view illustrating a fifth modification of the paper sheet storage device.

FIG. 16 is a conceptual view illustrating a first modification of first and second tapes.

FIG. 17 is a schematic plan view illustrating a second modification of the first and second tapes.

FIG. 18 is a schematic sectional view illustrating a fourth modification of the first and second tapes.

FIG. 19 is a schematic sectional view illustrating a fifth modification of the first and second tapes.

FIG. 20 is a schematic sectional view illustrating a sixth modification of the first and second tapes.

DETAILED DESCRIPTION

Embodiments will be described in detail below with reference to the drawings. In the drawings, the same elements or corresponding elements are denoted by the same reference numerals, and a description thereof is not repeated.

Paper Sheet Handling Machine

FIG. 1 and FIG. 2 illustrate an external appearance and internal configuration of a paper sheet handling machine 10 according to an embodiment. The paper sheet handling machine 10 is configured to handle paper sheets. In this example, the paper sheet handling machine 10 is configured as a banknote handling machine which handles banknotes (an example of the paper sheets). Such a banknote handling machine is installed, for example, in a financial institution such as a bank, or a back office of a retail store.

The paper sheet handling machine 10 includes a handling unit 20, a safe unit 30, and a controller 11. The handling unit 20 has a handling unit housing 21, a depositing unit 22, a dispensing unit 23, a temporary storage 24, a transport unit 25 in the handling unit, and a recognition unit 26. The safe unit 30 has a safe housing 31, a plurality of (eight in this example) storages 32, and a transport unit 33 of the safe. [Handling Unit Housing]

The handling unit housing 21 is formed in a rectangular parallelepiped box shape and houses the depositing unit 22, the dispensing unit 23, the temporary storage 24, the recognition unit 26, and the transport unit 25 in the handling unit. [Depositing Unit]

The depositing unit 22 is configured to receive banknotes placed therein. In this example, the depositing unit 22 has an inlet opened in an upper surface of the handling unit housing 21, and is configured to receive the banknotes placed therein through the inlet. The depositing unit 22 is provided with a

feeding mechanism that feeds the banknotes placed in the depositing unit 22 to the transport unit 25 in the handling unit one by one.

[Dispensing Unit]

The dispensing unit 23 is configured to dispense the banknotes. In this example, the dispensing unit 23 has an outlet opened in the upper surface of the handling unit housing 21, and is configured to stack a plurality of banknotes therein. The banknotes stacked in the dispensing unit 23 are fed from the dispensing unit 23 through the outlet. The dispensing unit 23 may be provided with a shutter that covers or uncovers the outlet.

[Temporary Storage]

The temporary storage 24 is configured to temporarily retain (store) the banknotes, and feed the temporarily stored banknotes. In this example, the temporary storage 24 consists of a paper sheet storage device 40. The paper sheet storage device 40 will be described in detail later.

[Transport Unit in the Handling Unit]

The transport unit 25 in the handling unit is configured to transport the banknotes in the handling unit 20. In this example, the transport unit 25 in the handling unit has a transport path connected to the depositing unit 22, the dispensing unit 23, the temporary storage 24, and the transport unit 33 in the safe. The transport unit 25 is configured to transport the banknotes among the depositing unit 22, the dispensing unit 23, the temporary storage 24, and the transport unit 33 in the safe. In this example, the transport unit 25 in the handling unit transports the banknotes such that short edges of the banknotes coincide with the transport direction. The transport path of the transport unit 25 in the handling unit is provided with, for example, a transport mechanism (e.g., a plurality of rollers or belts) for transporting the banknotes, a guide member for guiding the banknotes being transported, a branch mechanism (e.g., a branching pawl) for switching the transport direction of the banknotes, and a passage sensor for detecting the passage of the banknotes. The transport unit 25 in the handling unit has, for example, a drive mechanism (e.g., a motor or a gear) for driving the transport mechanism and the branch mechanism provided on the transport path.

[Recognition Unit]

The recognition unit 26 is configured to perform recognition of the banknotes. In the recognition, whether the banknotes are genuine or not, the denomination of the banknotes, and whether the banknotes are fit or unfit are recognized. In this example, the recognition unit 26 is provided in the transport path of the transport unit 25 in the handling unit, and is configured to perform the recognition of the banknotes passing through the transport path. For example, the recognition unit 26 includes various sensors such as a line sensor, a magnetic sensor, and an image sensor, a processing unit such as a CPU, and a storage unit such as a memory for storing a program and information for operating the processing unit.

[Safe Housing]

The safe housing 31 is formed in a rectangular parallel-epiped box shape, and houses the storages 32 and the transport unit 33 in the safe. The safe housing 31 has higher protection level than the housing 21 of the handling unit.

[Storage]

Each storage 32 is configured to store the banknotes and feed the stored banknotes. For example, the storage 32 is configured as a denomination-specific storage that stores the banknotes of a previously assigned denomination. Alternatively, the storage 32 may be configured as a mixed storage that stores banknotes of a plurality of denominations. In this

example, the storage 32 consists of the paper sheet storage device 40. The paper sheet storage device 40 will be described in detail later.

[Transport Unit in the Safe]

The transport unit 33 in the safe is configured to transport the banknotes in the safe unit 30. In this example, the transport unit 33 in the safe has a transport path connected to the plurality of storages 32 and the transport unit 25 in the handling unit, and is configured to transport the banknotes among the plurality of storages 32 and the transport unit 25 in the handling unit. In this example, just like the transport unit 25 in the handling unit, the transport unit 33 in the safe also transports the banknotes such that the short edges of the banknotes coincide with the transport direction. The transport path of the transport unit 33 in the safe is provided with, for example, a transport mechanism (e.g., a plurality of rollers or belts) for transporting the banknotes, a guide member for guiding the banknotes being transported, a branch mechanism (e.g., a branching pawl) for switching the transport direction of the banknotes, and a passage sensor for detecting the passage of the banknotes. The transport unit 33 in the safe has, for example, a drive mechanism (e.g., a motor or a gear) for driving the transport mechanism and the branch mechanism provided on the transport path.

[Controller]

The controller 11 is connected to the units of the paper sheet handling machine 10 (the depositing unit 22, the dispensing unit 23, the temporary storage 24, the transport unit 25 in the handling unit, the recognition unit 26, the storages 32, and the transport unit 33 in the safe in this example) so as to be able to transmit and receive signals to and from these units. The controller 11 receives detection signals of various sensors (e.g., the passage sensor) provided for the paper sheet handling machine 10. In accordance with the signals or information from the units and sensors of the paper sheet handling machine 10, the controller 11 controls each unit of the paper sheet handling machine 10, thereby controlling the paper sheet handling machine 10 to perform various processes (e.g., a depositing process and a dispensing process). For example, the controller 11 includes a processing unit such as a CPU, and a storage unit such as a memory for storing a program and information for operating the processing unit.

[Paper Sheet Storage Device]

Referring to FIG. 3 to FIG. 6, the paper sheet storage device 40 will be described. The paper sheet storage device 40 is configured to perform a storage operation of storing the paper sheets (banknotes in this example) sent into the device, and a feeding operation of feeding the paper sheets stored in the storage operation. In this example, the paper sheet storage device 40 includes a housing 41 and a storage mechanism 42.

FIG. 3 illustrates the paper sheet storage device 40 in which no paper sheet is stored, and FIG. 4 illustrates the paper sheet storage device 40 in which the maximum number of paper sheets are stored. In FIG. 6, for the sake of easy understanding, the units of the paper sheet storage device 40 are widely spaced from each other, a first tape 51 is indicated by a solid line, and a second tape 52 is indicated by a broken line.

For the convenience of description, the horizontal direction on the paper surface of FIG. 3 and FIG. 4 will be referred to as an "X axis direction," the vertical direction on the paper surface of FIG. 3 and FIG. 4 will be referred to as a "Y axis direction," and the direction perpendicular to the paper surface of FIG. 3 and FIG. 4 will be referred to as a "Z axis direction."

[Housing]

The housing **41** is formed in a rectangular parallelepiped box shape, and houses the storage mechanism **42**. The housing **41** is provided with an inlet/outlet port **400**. The inlet/outlet port **400** is configured to be able to allow the paper sheets to pass through. In this paper sheet storage device **40**, the paper sheets are stored and fed through the inlet/outlet port **400**.

[Storage Mechanism]

The storage mechanism **42** includes the first tape **51**, the second tape **52**, a first reel **53**, a second reel **54**, and a drum **55**. As illustrated in FIG. 5, in this example, the storage mechanism **42** includes a first reel shaft **61**, a second reel shaft **62**, a drum shaft **63**, a first torque limiter **57**, a second torque limiter **58**, and a drive mechanism **60**.

<First and Second Tapes>

Each of the first and second tapes **51** and **52** is formed in a belt shape.

As illustrated in FIG. 5, in this example, a pair of first tapes **51** and a pair of second tapes **52** are provided. That is, the paper sheet storage device **40** includes two first tapes **51** and two second tapes **52**. In the following description, one of the two first tapes **51** will be referred to as a "first tape **51a**" and the other will be referred to as a "first tape **51b**," and one of the two second tapes **52** will be referred to as a "second tape **52a**" and the other will be referred to as a "second tape **52b**." In this example, the two first tapes **51a** and **51b** are arranged in the Z axis direction, and the two second tapes **52a** and **52b** are arranged in the Z axis direction.

<First and Second Reels>

One end of each first tape **51** and one end of each second tape **52** are respectively connected to the first reel **53** and the second reel **54**. The first and second reels **53** and **54** are configured to be able to wind the first and second tapes **51** and **52**, respectively. Specifically, each of the first and second reels **53** and **54** is formed in a cylindrical shape. One end of the first tape **51** is fixed (e.g., with an adhesive) to an outer peripheral surface of the first reel **53**, and one end of the second tape **52** is fixed (e.g., with an adhesive) to an outer peripheral surface of the second reel **54**. In this example, a winding diameter of the first tape **51** on the first reel **53** is the same as a winding diameter of the second tape **52** on the second reel **54**.

As illustrated in FIG. 5, in this example, a pair of first reels **53** and a pair of second reels **54** are provided. That is, the paper sheet storage device **40** includes two first reels **53** and two second reels **54** respectively corresponding to the two first tapes **51** and the two second tapes **52**. In the following description, one of the two first reels **53** will be referred to as a "first reel **53a**" and the other will be referred to as a "first reel **53b**," and one of the two second reels **54** will be referred to as a "second reel **54a**" and the other will be referred to as a "second reel **54b**."

More specifically, in this example, the paper sheet storage device **40** includes the first reel **53a** corresponding to the first tape **51a** disposed at one side (an upper side in FIG. 5) in the Z axis direction, the first reel **53b** corresponding to the first tape **51b** disposed at the other side (a lower side in FIG. 5) in the Z axis direction, the second reel **54a** corresponding to the second tape **52a** disposed at one side in the Z axis direction, and the second reel **54b** corresponding to the second tape **52b** disposed at the other side in the Z axis direction.

<Drum>

The drum **55** is connected to the other end of the first tape **51** and the other end of the second tape **52**. The drum **55** is

configured to be able to wind the first tape **51** and the second tape **52**. Specifically, the drum **55** is formed in a cylindrical shape. The other end of the first tape **51** and the other end of the second tape **52** are fixed (e.g., with an adhesive) to an outer peripheral surface of the drum **55**.

As illustrated in FIG. 5, in this example, the first tape **51** and the second tape **52** are wound around the drum **55** to overlap with each other in the radial direction of the drum **55**. That is, the position of the first tape **51** in the axial direction of the drum **55** is the same as that of the second tape **52** in the axial direction of the drum **55**.

More specifically, in this example, the other ends of the two first tapes **51a** and **51b** and the other ends of the two second tapes **52a** and **52b** are connected to the drum **55**. The first tape **51a** and the second tape **52a** are wound around the drum **55** to overlap with each other in the radial direction of the drum **55**, and the first tape **51b** and the second tape **52b** are wound around the drum **55** to overlap with each other in the radial direction of the drum **55**. That is, the first tape **51a** and the second tape **52a** are wound around the drum **55** at the same position in the axial direction of the drum **55**. The first tape **51b** and the second tape **51b** are wound around the drum **55** at the same position in the axial direction of the drum **55**. However, the position of the first tape **51b** in the axial direction of the drum **55** is different from the positions of the first tape **51a** and the second tape **52a** in the axial direction of the drum **55**.

<First and Second Reel Shafts and Drum Shaft>

As illustrated in FIG. 5, the first reel shaft **61** and the second reel shaft **62** respectively extend in the Z axis direction, and are supported to be rotatable in the housing **41**. The drum shaft **63** extends in the Z axis direction and is supported to be rotatable in the housing **41**. The drum **55** is fixed to the drum shaft **63**.

<First and Second Torque Limiters>

As illustrated in FIG. 5, the first and second torque limiters **57** and **58** are respectively connected to the first and second reels **53** and **54**, and are configured to respectively regulate a torque acting on the first reel **53** and a torque acting on the second reel **54**. In this example, the first and second torque limiters **57** and **58** serve as torque controllers which respectively control the torque acting on the first reel **53** and the torque acting on the second reel **54**.

Specifically, the first reel **53** is fixed to the first reel shaft **61** via the first torque limiter **57**. The first torque limiter **57** is configured to connect the first reel **53** and the first reel shaft **61** to each other to transmit the torque between the first reel **53** and the first reel shaft **61** when the torque acting on the first reel **53** is smaller than a predetermined first set torque. The first reel **53** is also configured to disconnect the first reel **53** and the first reel shaft **61** from each other to block the transmission of the torque between the first reel **53** and the first reel shaft **61** when the torque acting on the first reel **53** increases to the first set torque.

Likewise, the second reel **54** is fixed to the second reel shaft **62** via the second torque limiter **58**. The second torque limiter **58** is configured to connect the second reel **54** and the second reel shaft **62** to each other to transmit the torque between the second reel **54** and the second reel shaft **62** when the torque acting on the second reel **54** is smaller than a predetermined second set torque. The second torque limiter **58** is also configured to disconnect the second reel **54** and the second reel shaft **62** from each other to block the transmission of the torque between the second reel **54** and the second reel shaft **62** when the torque acting on the second reel **54** increases to the second set torque.

As illustrated in FIG. 5, in this example, a pair of first torque limiters 57 and a pair of second torque limiters 58 are provided. That is, in this example, the paper sheet storage device 40 includes two first torque limiters 57 and two second torque limiters 58 respectively corresponding to the two first reels 53 and the two second reels 54. In the following description, one of the two first torque limiters 57 will be referred to as a “first torque limiter 57a” and the other will be referred to as a “first torque limiter 57b,” and one of the two second torque limiters 58 will be referred to as a “second torque limiter 58a” and the other will be referred to as a “second torque limiter 58b.”

More specifically, in this example, the paper sheet storage device 40 includes the first torque limiter 57a connected to the first reel 53a to regulate the torque acting on the first reel 53a, the first torque limiter 57b connected to the first reel 53b to regulate the torque acting on the first reel 53b, the second torque limiter 58a connected to the second reel 54a to regulate the torque acting on the second reel 54a, and the second torque limiter 58b connected to the second reel 54b to regulate the torque acting on the second reel 54b. The first reel 53a is fixed to the first reel shaft 61 via the first torque limiter 57a. The first torque limiter 57a is configured to connect the first reel 53a and the first reel shaft 61 to each other to transmit the torque between the first reel 53a and the first reel shaft 61 when the torque acting on the first reel 53a is smaller than the first set torque. The first torque limiter 57a is configured to disconnect the first reel 53a and the first reel shaft 61 from each other to block the transmission of the torque between the first reel 53a and the first reel shaft 61 when the torque acting on the first reel 53a increases to the first set torque. The first torque limiter 57b and the second torque limiters 58a and 58b are configured in the same manner as the first torque limiter 57a.

<Drive Mechanism>

As illustrated in FIG. 5, the drive mechanism 60 is configured to rotationally drive the first reel shaft 61, the second reel shaft 62, and the drum shaft 63. For example, the drive mechanism 60 includes a motor that generates the torque, and a mechanical component (e.g., a gear or a one-way clutch) for transmitting the torque of the motor to the first reel shaft 61, the second reel shaft 62, and the drum shaft 63.

<Transport Guide>

As illustrated in FIG. 3 and FIG. 4, in this example, the drum 55 is disposed on a rear side (a side remote from the inlet/outlet port 400) of the housing 41, and the first reel 53 and the second reel 54 are disposed adjacent to the inlet/outlet port 400 of the housing 41. The storage mechanism 42 has a transport guide 70.

The transport guide 70 has a transport path (a transport path of the paper sheets) extending from the inlet/outlet port 400 toward the drum 55, and is configured to transport the paper sheets between the inlet/outlet port 400 and the drum 55. In this example, the transport guide 70 transports the banknotes such that short edges thereof coincide with the transport direction.

In this example, the transport guide 70 extends in the X axis direction in the housing 41 from the inlet/outlet port 400 toward the drum 55 (that is, toward the rear side of the housing 41). The transport guide 70 configured in this manner divides an internal space of the housing 41 into a first space S1 and a second space S2. The drum 55 is disposed in the first space S1. The first and second reels 53 and 54 are disposed in the second space S2. The transport guide 70 has a fixed guide 71 and a movable guide 72.

<Fixed Guide>

The fixed guide 71 has a transport path (a transport path of the paper sheets) extending from the inlet/outlet port 400 toward the movable guide 72, and is configured to transport the paper sheets between the inlet/outlet port 400 and the movable guide 72. In this example, the fixed guide 71 has a guide member forming the transport path of the paper sheets, a transport mechanism (four rollers in this example) for transporting the paper sheets, and a drive mechanism (e.g., a motor or a gear) for driving the transport mechanism.

<Movable Guide>

The movable guide 72 has a transport path (a transport path of the paper sheets) extending from the fixed guide 71 toward the drum 55, and is configured to transport the paper sheets between the fixed guide 71 and the drum 55. In FIG. 3, the movable guide 72 is encircled with a broken line.

In this example, the movable guide 72 has a guide member forming the transport path of the paper sheets, a first transport belt 73, a second transport belt 74, and a drive mechanism (e.g., a motor or a gear) for driving the first and second transport belts 73 and 74. The first transport belt 73 is rotatably wound around a plurality of (three in this example) pulleys. The second transport belt 74 is rotatably wound around a plurality of (four in this example) pulleys. The first and second transport belts 73 and 74 are provided at an end of the transport path of the movable guide 72 (an end closer to the fixed guide 71), and are disposed to face each other with a predetermined gap formed therebetween. The first and second transport belts 73 and 74 are configured to rotate with the paper sheets interposed therebetween, thereby transporting the paper sheets.

The movable guide 72 is configured to swing about a swing shaft 72a extending in the Z axis direction. In this example, the swing shaft 72a constitutes a rotating shaft of one of the three pulleys around which the first transport belt 73 is wound. Furthermore, a tip end portion of the movable guide 72 is biased in a direction approaching the drum 55 (a clockwise direction in FIG. 3) by a biasing member (e.g., a spring, not illustrated). A pressing roller 75 is provided at the tip end portion of the movable guide 72. The pressing roller 75 is configured to abut on an outer peripheral surface of the tape (the first tape 51 in this example) wound around the drum 55 to press the tape. The movable guide 72 configured in this manner swings about the swing shaft 72a extending in the Z axis direction, in accordance with a change in an apparent diameter of the drum 55 (i.e., a diameter of the outermost peripheral surface of the drum 55 with the first and second tapes 51 and 52 wound around the drum 55 and the paper sheets).

<First and Second Transport Rollers (Sandwiching Portion)>

In this example, the storage mechanism 42 includes a first transport roller 81 and a second transport roller 82. The first transport roller 81 and the second transport roller 82 are provided at the end of the transport path of the movable guide 72 (an end closer to the drum 55) and are disposed to face each other with a predetermined gap formed therebetween. The first transport roller 81 and the second transport roller 82 are configured to rotate with the first tape 51 and the second tape 52 sandwiched therebetween. The first transport roller 81 and the second transport roller 82 constitute a sandwiching portion 80 that sandwiches the paper sheets between the first tape 51 and the second tape 52.

<Guide Roller, Intermediate Roller, and Auxiliary Roller>

In this example, the storage mechanism 42 includes a plurality of (two in this example) first guide rollers 85, a

plurality of (seven in this example) second guide rollers **86**, an intermediate roller **87**, and an auxiliary roller **88**.

The plurality of first guide rollers **85** are provided in the first space **S1**. The intermediate roller **87** is provided at an intermediate portion of the movable guide **72** (specifically, a portion between the first transport belt **73** and the first transport roller **81**). The plurality of first guide rollers **85** and the intermediate roller **87** are configured to guide the first tape **51** between the first reel **53** and the sandwiching portion **80**. That is, in this example, the first tape **51** sequentially passes through the plurality of first guide rollers **85**, the intermediate roller **87**, and the sandwiching portion **80** to reach the drum **55** from the first reel **53**.

Some (five in this example) of the plurality of second guide rollers **86** are disposed in the first space **S1**, and the rest (two in this example) of them are disposed in the second space **S2**. The plurality of second guide rollers **86** is configured to guide the second tape **52** between the second reel **54** and the sandwiching portion **80**. That is, in this example, the second tape **52** sequentially passes through the plurality of second guide rollers **86** and the sandwiching portion **80** to reach the drum **55** from the second reel **54**. In this example, the second tape **52** is routed from the first space **S1** to the second space **S2** to bypass the tip end of the movable guide **72**.

The auxiliary roller **88** is provided at an intermediate portion of the movable guide **72**. The auxiliary roller **88** is configured to make contact with the first tape **51** to guide the first tape **51** when the movable guide **72** swings in a direction away from the drum **55** (a counterclockwise direction in FIG. 3).

[Operation of Paper Sheet Storage Device]

Next, the operation performed by the paper sheet storage device **40** will be described. The paper sheet storage device **40** is configured to perform the storage operation of storing the paper sheets sent into the device and the feeding operation of feeding the paper sheets stored in the storage operation.

<Storage Operation>

In the storage operation, the first reel **53** and the second reel **54** rotate in a forward direction (the clockwise direction in FIG. 3). Then, as illustrated in FIG. 6, a paper sheet **100** is sandwiched between the first tape **51** and the second tape **52**, and the first tape **51** and the second tape **52** are wound around the drum **55** together with the paper sheet **100**. In this state, the first tape **51** is positioned outside the paper sheet **100** (sandwiched between the first tape **51** and the second tape **52**) in the radial direction of the drum **55**, and the second tape **52** is positioned radially inside the paper sheet. Specifically, an inner side of the first tape **51** (an inner side in the radial direction of the drum **55**) makes contact with an outer side of the paper sheet **100** (an outer side in the radial direction of the drum **55**), and an outer side of the second tape **52** makes contact with an inner side of the paper sheet **100**. In this way, the paper sheet **100** is stored.

Specifically, the paper sheet sent to the inlet/outlet port **400** of the paper sheet storage device **40** is transported from the inlet/outlet port **400** toward the movable guide **72** through the transport path of the fixed guide **71**, and is sent to the movable guide **72**. The paper sheet sent to the movable guide **72** is transported toward the intermediate roller **87** by the first and second transport belts **73** and **74** through the transport path of the movable guide **72**, transported toward the sandwiching portion **80** from the intermediate roller **87** by the first tape **51** running between the intermediate roller **87** and the sandwiching portion **80** (the first transport roller **81**), and sandwiched between the first and second tapes **51**

and **52** at the sandwiching portion **80**. Then, the paper sheet sandwiched between the first and second tapes **51** and **52** at the sandwiching portion **80** is wound around the drum **55** together with the first and second tapes **51** and **52**.

<Rotation Control in Storage Operation>

In the storage operation, the drive mechanism **60** controls the rotations of the first reel shaft **61**, the second reel shaft **62**, and the drum shaft **63** such that the first reel **53**, the second reel **54**, and the drum **55** rotate in the forward direction (a direction indicated by solid arrows in FIG. 5) with a tension acted on the first tape **51** and the second tape **52**.

In this example, the drive mechanism **60** allows the drum shaft **63** to rotate in the forward direction. This causes the drum **55** fixed to the drum shaft **63** to rotate in the forward direction. The drive mechanism **60** does not allow the first and second reel shafts **61** and **62** to rotate so that the first and second reel shafts **61** and **62** are kept in a stopped state. Thus, the first reel **53** fixed to the first reel shaft **61** via the first torque limiter **57** does not rotate, and is kept in a stopped state. Likewise, the second reel **54** fixed to the second reel shaft **62** via the second torque limiter **58** does not rotate, and is kept in a stopped state.

In this way, when the drum **55** rotates in the forward direction with the first and second reels **53** and **54** kept in the stopped state, a tension acts on the first and second tapes **51** and **52** running between the first and second reels **53** and **54** and the drum **55**. Further, a torque corresponding to the tension acting on the first and second tapes **51** and **52** acts on the first and second reels **53** and **54**.

Then, when the torque acting on the first reel **53** increases to the set torque of the first torque limiter **57** (first set torque) as a result of the increase in the tension acting on the first tape **51**, the first torque limiter **57** disconnects the first reel **53** and the first reel shaft **61**, so that the first reel **53** can rotate in the forward direction. Likewise, when the torque acting on the second reel **54** increases to the set torque of the second torque limiter **58** (second set torque) as a result of the increase in the tension acting on the second tape **52**, the second torque limiter **58** disconnects the second reel **54** and the second reel shaft **62** so that the second reel **54** can rotate in the forward direction.

Under such control, in the storage operation, the tension corresponding to the set torque of the first torque limiter **57** (the first set torque) always acts on the first tape **51**, and the tension corresponding to the set torque of the second torque limiter **58** (the second set torque) always acts on the second tape **52**.

The drive mechanism **60** may be configured to rotationally drive the first reel shaft **61** and the second reel shaft **62** together with the drum **55** in the storage operation. In this case, the rotations of the drum **55**, the first reel shaft **61**, and the second reel shaft **62** are controlled such that the speed at which the first reel **53** rewinds the first tape **51** and the speed at which the second reel **54** rewinds the second tape **52** are faster than the speed at which the drum **55** winds the first and second tapes **51** and **52**. This allows the tensions corresponding to the first and second set torques to respectively act on the first and second tapes **51** and **52**.

<Feeding Operation>

In the feeding operation, the drum **55**, the first reel **53**, and the second reel **54** rotate in an opposite direction (the counterclockwise direction in FIG. 3). Thus, the first tape **51** is wound around the first reel **53**, the second tape **52** is wound around the second reel **54**, and the paper sheet **100** sandwiched between the first and second tapes **51** and **52** is fed from the drum **55**.

Specifically, before the start of the feeding operation, the paper sheet 100 is sandwiched between the first and second tapes 51 and 52, and the first and second tapes 51 and 52 are wound around the drum 55 together with the paper sheet 100. In this state, the first tape 51 is positioned outside the paper sheet 100 (the paper sheet 100 sandwiched between the first tape 51 and the second tape 52) in the radial direction of the drum 55, and the second tape 52 is positioned radially inside the paper sheet. Specifically, the inner side of the first tape 51 (inner side in the radial direction of the drum 55) makes contact with the outer side of the paper sheet 100 (outer side in the radial direction of the drum 55), and the outer side of the second tape 52 makes contact with the inner side of the paper sheet 100. When the feeding operation is started, the paper sheet sandwiched between the first tape 51 and the second tape 52 and wound around the drum 55 together with the first tape 51 and the second tape 52 is transported to the sandwiching portion 80 provided at the end of the transport path of the movable guide 72 (the end near the drum 55). The paper sheet is released from the sandwiched state between the first tape 51 and the second tape 52 at the sandwiching portion 80. The paper sheet is transported toward the intermediate roller 87 from the sandwiching portion 80 by the first tape 51 running between the sandwiching portion 80 (the first transport roller 81) and the intermediate roller 87. The paper sheet is transported toward the fixed guide 71 from the intermediate roller 87 by the first and second transport belts 73 and 74, and sent to the fixed guide 71. Then, the paper sheet sent to the fixed guide 71 is transported toward the inlet/outlet port 400 from the movable guide 72 through the transport path of the fixed guide 71, and is fed out of the inlet/outlet port 400.

<Rotation Control in Feeding Operation>

In the feeding operation, the drive mechanism 60 controls the rotations of the first reel shaft 61, the second reel shaft 62, and the drum shaft 63 such that the first reel 53, the second reel 54, and the drum 55 rotate in the opposite direction (a direction opposite to the direction indicated by the solid arrows in FIG. 5) with the tension acting on the first tape 51 and the second tape 52.

In this example, the drive mechanism 60 rotates the drum shaft 63 in the opposite direction. This allows the drum 55 fixed to the drum shaft 63 to rotate in the opposite direction. Further, the drive mechanism 60 rotates the first reel shaft 61 and the second reel shaft 62 in the opposite direction. This allows the first reel 53 fixed to the first reel shaft 61 via the first torque limiter 57 to rotate in the opposite direction. Likewise, the second reel 54 fixed to the second reel shaft 62 via the second torque limiter 58 rotates in the opposite direction.

The drive mechanism 60 controls the rotations of the first reel shaft 61, the second reel shaft 62, and the drum shaft 63 such that the tension acts on each of the first and second tapes 51 and 52. For example, the drive mechanism 60 controls the rotations of the first reel shaft 61, the second reel shaft 62, and the drum shaft 63 such that the speed at which the first and second reels 53 and 54 respectively wind (take in) the first and second tapes 51 and 52 is always faster than the speed at which the drum 55 rewinds (feeds) the first and second tapes 51 and 52.

When the torque acting on the first reel 53 increases to the set torque of the first torque limiter 57 (the first set torque) as a result of the increase in the tension acting on the first tape 51, the first torque limiter 57 disconnects the first reel 53 and the first reel shaft 61, so that the first reel 53 slips. Likewise, when the torque acting on the second reel 54 increases to the set torque of the second torque limiter 58

(the second set torque) as a result of the increase in the tension acting on the second tape 52, the second torque limiter 58 disconnects the second reel 54 and the second reel shaft 62, so that the second reel 54 slips.

Under such control, in the feeding operation, the tension corresponding to the set torque of the first torque limiter 57 (the first set torque) always acts on the first tape 51, and the tension corresponding to the set torque of the second torque limiter 58 (the second set torque) always acts on the second tape 52.

[Tension Acting on Tape]

In the paper sheet storage device 40, the tension acting on the first tape 51 in the storage operation is greater than that acting on the second tape 52 in the storage operation. Likewise, the tension acting on the first tape 51 in the feeding operation is greater than that acting on the second tape 52 in the feeding operation. For example, the tension acting on the first tape 51 is in the range of 110% to 130% of the tension acting on the second tape 52. In more detail, with reference to FIG. 5, in both of the storage operation and the feeding operation in this example, the first tape 51a receives a greater tension than the second tape 52a, and the first tape 51b receives a greater tension than the second tape 52b.

In this example, the maximum torque of the first reel 53 regulated by the first torque limiter 57 is greater than that of the second reel 54 regulated by the second torque limiter 58. Specifically, the set torque of the first torque limiter 57 (the first set torque) is greater than the set torque of the second torque limiter 58 (the second set torque). In more detail, with reference to FIG. 5, the set torque of the first torque limiter 57a is greater than that of the second torque limiter 58a, and the set torque of the first torque limiter 57b is greater than that of the second torque limiter 58b.

As the torque acting on the first reel 53 increases, the tension acting on the first tape 51 tends to increase. Likewise, as the torque acting on the second reel 54 increases, the tension acting on the second tape 52 tends to increase. Consequently, when the maximum torque of the first reel 53 is made greater than that of the second reel 54, the tension acting on the first tape 51 can be made greater than that acting on the second tape 52.

[Advantages of Embodiment]

As can be seen, the tension acting on the first tape 51 in the storage operation is made greater than that acting on the second tape 52 in the storage operation. Thus, when the first tape 51 and the second tape 52 are wound around the drum 55 with the paper sheet sandwiched therebetween, the first tape 51 positioned outside the paper sheet in the radial direction of the drum 55 can be tightly wound around the drum 55. This can make the first tape 51 less loosened in the storage operation, and can reduce the deterioration of the winding state of the paper sheet on the drum 55.

Further, the tension acting on the first tape 51 in the feeding operation is made greater than that acting on the second tape 52 in the feeding operation. This can make the first tape 51 less loosened in the feeding operation, and can reduce the deterioration of the winding state of the paper sheet on the drum 55.

In addition, since the deterioration of the winding state of the paper sheet on the drum 55 can be reduced, the frequency of pause of the paper sheet handling machine 10 caused by a winding failure of the paper sheet in the paper sheet storage device 40 can be reduced.

[Abutting Member]

As illustrated in FIG. 3 and FIG. 4, in this example, an abutting member 43 is provided in the housing 41. The

abutting member 43 is configured to make contact with the tip end portion of the movable guide 72 biased in the direction approaching the drum 55 (the clockwise direction in FIG. 3) when the apparent diameter of the drum 55 is smaller than a predetermined diameter, thereby regulating the swing of the movable guide 72 (swing in the direction approaching the drum 55). When the apparent diameter of the drum 55 is smaller than the predetermined diameter, the abutting member 43 configured in this manner can avoid contact between the pressing roller 75 provided at the tip end portion of the movable guide 72 and the tape (the first tape 51 in this example) wound around the drum 55.

When the first tape 51 and the second tape 52 wound around the drum 55 are pressed by the pressing roller 75 in a situation where the number of paper sheets wound around the drum 55 is relatively small (that is, when the apparent diameter of the drum 55 is relatively small), the first and second tapes 51 and 52 may possibly be misaligned with each other due to variation in parts or assembly of the pressing roller 75 and the movable guide 72. In a situation where the number of paper sheets wound around the drum 55 is relatively large (that is, when the apparent diameter of the drum 55 is relatively large), the misalignment of the first tape 51 and the second tape 52 caused by the variation in parts and assembly of the pressing roller 75 and the movable guide 72 is reduced by friction of the paper sheets wound around the drum 55 together with the first tape 51 and the second tape 52.

Consequently, when the apparent diameter of the drum 55 is smaller than the predetermined diameter, the pressing roller 75 provided at the tip end portion of the movable guide 72 is blocked from making contact with the tape (the first tape 51 in this example) wound around the drum 55. This can prevent the misalignment of the first tape 51 and the second tape 52 caused by the variation in parts and assembly of the pressing roller 75 and the movable guide 72. [Regulating Wall]

As illustrated in FIG. 3 and FIG. 7, in this example, the movable guide 72 is provided with regulating walls 76. As illustrated in FIG. 7, the regulating walls 76 are disposed at both sides in a width direction of the second tape 52, and are configured to make contact with the second tape 52 when the traveling position of the second tape 52 is shifted in the width direction. The regulating walls 76 configured in this manner can regulate the shift of the traveling position of the second tape 52 (shift in the width direction).

First Modification of Paper Sheet Storage Device

As illustrated in FIG. 8, the drive mechanism 60 may have a first driver 65 and a second driver 66 respectively corresponding to the first reel 53 and the second reel 54. In the first modification, the paper sheet storage device is not provided with the first and second torque limiters 57 and 58 illustrated in FIG. 5. The first reel 53 is fixed to the first reel shaft 61, and is configured to be rotationally driven together with the first reel shaft 61. The second reel 54 is fixed to the second reel shaft 62, and configured to be rotationally driven together with the second reel shaft 62. The paper sheet storage device 40 further includes a torque controller 67. Other configurations of the paper sheet storage device 40 illustrated in FIG. 8 are the same as those of the paper sheet storage device 40 illustrated in FIG. 3 to FIG. 7. [Driver]

The first driver 65 is configured to rotationally drive the first reel shaft 61, thereby rotating the first reel 53. The second driver 66 is configured to rotationally drive the

second reel shaft 62, thereby rotating the second reel 54. For example, each of the first and second drivers 65 and 66 may be a motor.

[Torque Controller]

The torque controller 67 is configured to control the torque acting on the first reel 53 and the torque acting on the second reel 54. Specifically, in at least one of the storage operation or the feeding operation, the torque controller 67 is configured to control the first and second drivers 65 and 66 such that the torque acting on the first reel 53 when the first driver 65 rotationally drives the first reel 53 is greater than the torque acting on the second reel 54 when the second driver 66 rotationally drives the second reel 54. For example, the torque controller 67 includes a processing unit such as a CPU, and a storage unit such as a memory for storing a program and information for operating the processing unit. The torque controller 67 may be part of the controller 11 illustrated in FIG. 2.

[Advantages of First Modification of Paper Sheet Storage Device]

As described above, controlling the first and second drivers 65 and 66 can make the tension acting on the first tape 51 greater than that acting on the second tape 52 in the storage operation (or the feeding operation). Thus, the first tape 51 can be wound more tightly around the drum 55 than the second tape 52, thereby making the first tape 51 less loosened in the storage operation (or the feeding operation). This can reduce the deterioration of the winding state of the paper sheets on the drum 55.

Further, since the torque acting on the first reel 53 and the torque acting on the second reel 54 can be easily regulated by electrical control, the torques can be set to an appropriate level.

The drive mechanism 60 may have a drum driver (not illustrated) which rotationally drives the drum shaft 63, thereby rotating the drum 55. The torque controller 67 may be configured to control the torque acting on the drum shaft 63 by controlling the drum driver. In this configuration, the torque acting on each of the first reel 53, the second reel 54, and the drum shaft 63 can be controlled to regulate the tension acting on each of the first tape 51 and the second tape 52.

Second Modification of Paper Sheet Storage Device

As illustrated in FIG. 9, a winding diameter D1 of the first tape 51 on the first reel 53 may be smaller than a winding diameter D2 of the second tape 52 on the second reel 54. In the paper sheet storage device of the second modification illustrated in FIG. 9, the diameter of the first reel 53 is smaller than that of the second reel 54, and the maximum torque of the first reel 53 regulated by the first torque limiter 57 is identical to that of the second reel 54 regulated by the second torque limiter 58. Other configurations of the paper sheet storage device 40 illustrated in FIG. 9 are the same as those of the paper sheet storage device 40 illustrated in FIG. 3 to FIG. 7.

As the winding diameter D1 of the first tape 51 in the first reel 53 decreases, the tension acting on the first tape 51 tends to increase. Likewise, as the winding diameter D2 of the second tape 52 on the second reel 54 decreases, the tension acting on the second tape 52 tends to increase. Consequently, when the winding diameter D1 of the first tape 51 on the first reel 53 is made smaller than the winding diameter D2 of the second tape 52 on the second reel 54, the tension acting on the first tape 51 can be made greater than that acting on the second tape 52. This can make the first tape 51 less loosened

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in the storage operation (or the feeding operation), thereby reducing the deterioration of the winding state of the paper sheet on the drum 55.

In the example of FIG. 9, the maximum torque of the first reel 53 regulated by the first torque limiter 57 (i.e., the first set torque) may be different from, or greater than, the maximum torque of the second reel 54 regulated by the second torque limiter 58 (i.e., the second set torque). Specifically, the maximum torque of the first reel 53 regulated by the first torque limiter 57, the maximum torque of the second reel 54 regulated by the second torque limiter 58, the winding diameter D1 of the first tape 51 on the first reel 53, and the winding diameter D2 of the second tape 52 on the second reel 54 may be determined such that the tension acting on the first tape 51 in the storage operation (or the feeding operation) is greater than the tension acting on the second tape 52 in the storage operation (or the feeding operation).

Third Modification of Paper Sheet Storage Device

As illustrated in FIG. 10, the first and second tapes 51 and 52 may run between the first and second reels 53 and 54 and the sandwiching portion 80 such that the paths from the first and second reels 53 and 54 to the drum 55 partially overlap with each other. With reference to FIG. 10 to FIG. 13, the third modification of the paper sheet storage device will be described below.

In the third modification, the storage mechanism 42 may have a common roller 89 instead of some of the plurality of first guide rollers 85 and the plurality of second guide rollers 86. The common roller 89 is disposed in the first space S1, and is configured to guide the first and second tapes 51 and 52 between the first and second reels 53 and 54 and the sandwiching portion 80. That is, in this example, the first tape 51 sequentially passes through the common roller 89, the intermediate roller 87, and the sandwiching portion 80 before reaching the drum 55. The second tape 52 sequentially passes through the plurality of second guide rollers 86, the common roller 89, the intermediate roller 87, and the sandwiching portion 80 before reaching the drum 55. In this way, the path of the first tape 51 from the first reel 53 to the drum 55 and the path of the second tape 52 from the second reel 54 to the drum 55 overlap with each other in a path from the common roller 89 to the drum 55 via the intermediate roller 87 and the sandwiching portion 80.

As illustrated in FIG. 12, the first tape 51 is wound around the drum 55 after passing through the sandwiching portion 80. On the other hand, the second tape 52 is wound along the outer peripheral surface of the drum 55 after passing through the sandwiching portion 80, separated from the outer peripheral surface of the drum 55 to be wound around the second transport roller 82, and then wound around the drum 55.

Other configurations of the paper sheet storage device 40 illustrated in FIG. 10 to FIG. 13 are the same as those of the paper sheet storage device 40 illustrated in FIG. 3 to FIG. 7.

Fourth Modification of Paper Sheet Storage Device

As illustrated in FIG. 14, the paper sheet storage device 40 may include a single first tape 51 and a single second tape 52. In the example of FIG. 14, the paper sheet storage device 40 includes a single first reel 53 (not illustrated) and a single second reel 54 (not illustrated) respectively corresponding to the single first tape 51 and the single second tape 52, the drum 55, a single first torque limiter 57 (not illustrated) corresponding to the first reel 53, and a single second torque

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limiter 58 (not illustrated) corresponding to the second reel 54. Other configurations of the paper sheet storage device 40 illustrated in FIG. 14 are the same as those of the paper sheet storage device 40 illustrated in FIG. 3 to FIG. 7.

Fifth Modification of Paper Sheet Storage Device

As illustrated in FIG. 15, the number of first tapes 51 and the number of second tapes 52 may be different from each other. In the example of FIG. 15, the paper sheet storage device 40 includes a single first tape 51, two second tapes 52, a single first reel 53 (not illustrated) and two second reels 54 (not illustrated) respectively corresponding to the single first tape 51 and the two second tapes 52, the drum 55, a single first torque limiter 57 (not illustrated) corresponding to the single first reel 53, and two second torque limiters 58 (not illustrated) corresponding to the two second reels 54. Other configurations of the paper sheet storage device 40 illustrated in FIG. 15 are the same as those of the paper sheet storage device 40 illustrated in FIG. 3 to FIG. 7.

In the example of FIG. 15, the first tape 51 and the second tapes 52 are wound around the drum 55 not to overlap with each other in the radial direction of the drum 55. That is, in the example of FIG. 15, the position of the first tape 51 in the axial direction of the drum 55 is different from the positions of the second tapes 52 in the axial direction of the drum 55.

Also in the third to fifth modifications of the paper sheet storage device described above, the first tape 51 is positioned outside the paper sheet wound around the drum 55 (the paper sheet sandwiched between the first and second tapes 51 and 52) in the radial direction of the drum 55, and the second tape 52 is positioned radially inside the paper sheet. The tension acting on the first tape 51 is made greater than the tension acting on the second tape 52 in at least one of the storage operation or the feeding operation, so that the first tape 51 can be wound more tightly around the drum 55 than the second tape 52. This can make the first tape 51 less loosened in the storage operation (or the feeding operation), thereby reducing the deterioration of the winding state of the paper sheet on the drum 55.

First Modification of First and Second Tapes

As illustrated in FIG. 16, the first tape 51 may be thicker than the second tape 52. For example, the first tape 51 may be made of a laminate of a plurality of tapes (e.g., a tape serving as the second tape 52).

With the first tape 51 made thicker than the second tape 52, the first tape 51 can be improved in durability against the tension. This can reduce the deterioration of the tape 51 due to the tension.

In addition, this can improve the strength of the first tape 51 against reaction force of the paper sheet sandwiched between the first tape 51 and the second tape 52, and the paper sheet can be tightly wound around the drum 55 by the first tape 51. Thus, the deterioration of the winding state of the paper sheet on the drum 55 can be reduced.

Furthermore, making the second tape 52 thinner than the first tape 51 can reduce the apparent radius of the drum 55. This can reduce a space required for storing the drum 55, or increase the number of paper sheets that can be stored in the paper sheet storage device 40.

Second Modification of First and Second Tapes

As illustrated in FIG. 17, the first tape 51 may be wider than the second tape 52.

With the first tape 51 made wider than the second tape 52, the first tape 51 can be improved in durability against the tension. This can reduce the deterioration of the first tape 51 due to the tension.

In addition, this can increase the contact area between the first tape 51 and the paper sheet, so that the paper sheet can be tightly wound around the drum 55 by the first tape 51. Thus, the deterioration of the winding state of the paper sheet on the drum 55 can be reduced.

Third Modification of First and Second Tapes

The first tape 51 may have higher rigidity than the second tape 52.

The first tape 51 having higher rigidity than the second tape 52 can improve the first tape 51 in durability against the tension. This can reduce the deterioration of the first tape 51 due to the tension.

In addition, this can improve the strength of the first tape 51 against the reaction force of the paper sheet sandwiched between the first tape 51 and the second tape 52, so that the paper sheet can be tightly wound around the drum 55 by the first tape 51. This can reduce the deterioration of the winding state of the paper sheet in the drum 55.

Fourth Modification of First and Second Tapes

As illustrated in FIG. 18, a portion of the first tape 51 near the drum 55 may be thicker than a portion of the first tape 51 near the first reel 53. Likewise, a portion of the second tape 52 near the drum 55 may be thicker than a portion of the second tape 52 near the second reel 54. Specifically, a portion of the first tape 51 (or the second tape 52) of a predetermined length from its end fixed to the drum 55 may be thicker than the remaining portion of the first tape 51 (or the second tape 52). FIG. 18 illustrates a cross section taken along the longitudinal direction and the thickness direction of the first tape 51 (or the second tape 52).

The first tape 51, the second tape 52, and the paper sheet which are wound around the drum 55 gradually decrease in radius of curvature toward the center of the drum 55. Thus, it becomes more difficult to wind the paper sheet by the first tape 51 and the second tape 52 (particularly, the first tape 51) as the distance to the center of the drum 55 decreases.

Consequently, when the first tape 51 whose portion near the drum 55 is made thicker than a portion near the first reel 53 is wound around the drum 55, a portion of the first tape 51 closer to the center of the drum 55 can be thicker. This can improve the strength of the first tape 51 against the reaction force of the paper sheet sandwiched between the first tape 51 and the second tape 52, so that the paper sheet can be tightly wound around the drum 55 by the first tape 51. Thus, the deterioration of the winding state of the paper sheet on the drum 55 can be reduced.

Also, when the second tape 52 whose portion near the drum 55 is made thicker than a portion near the second reel 54 is wound around the drum 55, a portion of the second tape 52 closer to the center of the drum 55 can be thicker. This can improve the strength of the second tape 52 against the reaction force of the paper sheet sandwiched between the first tape 51 and the second tape 52, so that the paper sheet can be curved along the second tape 52 by the second tape

52. Thus, the deterioration of the winding state of the paper sheet on the drum 55 can be reduced.

Further, when the first reel 53, to which one end of the first tape 51 has been connected, is stored outside the paper sheet storage device 40, the first tape 51 is wound around the first reel 53. In this case, the portion of the first tape 51 near the drum 55 forms outer turns of the first tape 51 wound around the first reel 53. Consequently, with the portion of the first tape 51 near the drum 55 made thicker than the portion of the first tape 51 near the first reel 53, the outer turns of the first tape 51 wound around the first reel 53 can be made thicker. This can improve durability of the outer turns of the first tape 51 wound around the first reel 53 against scratches.

Likewise, when the second reel 54, to which one end of the second tape 52 has been connected, is stored outside the paper sheet storage device 40, the second tape 52 is wound around the second reel 54. In this case, a portion of the second tape 52 near the drum 55 forms outer turns of the second tape 52 wound around the second reel 54. Consequently, with the portion of the second tape 52 near the drum 55 made thicker than the portion of the second tape 52 near the second reel 54, the outer turns of the second tape 52 wound around the second reel 54 can be made thicker. This can improve durability of the outer turns of the second tape 52 wound around the second reel 54 against scratches.

When the paper sheet storage device 40 is used as the temporary storage 24, it may be repeated that some banknotes (an example of the paper sheets) are temporarily stored in the paper sheet storage device 40, and then some of the temporarily stored banknotes are fed from the paper sheet storage device 40. In such a case, the portion of the first tape 51 near the drum 55 tends to be used more frequently than the portion of the first tape 51 near the first reel 53. Likewise, the portion of the second tape 52 near the drum 55 tends to be used more frequently than the portion of the second tape 52 near the second reel 54.

Thus, when the paper sheet storage device 40 is used as the temporary storage 24 (that is, the temporary storage 24 in which some banknotes are temporarily stored and fed in a repeated manner), the portion of the first tape 51 near the drum 55 is made thicker than the portion of the first tape 51 near the first reel 53, so that the portion of the first tape 51 which is used with a relatively high frequency can be made thicker. This can improve durability of the portion of the first tape 51 used with a relatively high frequency against abrasion, and can reduce the deterioration of the first tape 51 due to the abrasion.

Likewise, when the paper sheet storage device 40 is used as the temporary storage 24, the portion of the second tape 52 near the drum 55 is made thicker than the portion of the second tape 52 near the second reel 54, so that the portion of the second tape 52 which is used with a relatively high frequency can be made thicker. This can improve durability of the portion of the second tape 52 used with a relatively high frequency against abrasion, and can reduce the deterioration of the second tape 52 due to the abrasion.

Fifth Modification of First and Second Tapes

As illustrated in FIG. 19, the portion of the first tape 51 near the first reel 53 may be thicker than the portion of the first tape 51 near the drum 55. Likewise, the portion of the second tape 52 near the second reel 54 may be thicker than the portion of the second tape 52 near the drum 55. Specifically, a portion of the first tape 51 (or the second tape 52) of a predetermined length from its end fixed to the first reel 53 (or the second reel 54) may be thicker than the remaining

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portion of the first tape **51** (or the second tape **52**). FIG. **19** illustrates the cross section taken along the longitudinal direction and the thickness direction of the first tape **51** (or the second tape **52**).

When the paper sheet storage device **40** is used as the storage **32**, it may be repeated that some banknotes are fed from the paper sheet storage device **40**, and then some other banknotes are stored in the paper sheet storage device **40** to keep the paper sheet storage device **40** full (or almost full). In such a case, the portion of the first tape **51** near the first reel **53** tends to be used more frequently than the portion of the first tape **51** near the drum **55**. Likewise, the portion of the second tape **52** near the second reel **54** tends to be used more frequently than the portion of the second tape **52** near the drum **55**.

Thus, when the paper sheet storage device **40** is used as the storage **32** (that is, the storage **32** in which some banknotes are fed and then some other banknotes are stored such that the full state is kept), the portion of the first tape **51** near the first reel **53** is made thicker than the portion of the first tape **51** near the drum **55**, so that the portion of the first tape **51** which is used with a relatively high frequency can be made thicker. This can improve durability of the portion of the first tape **51** used with a relatively high frequency against abrasion, and can reduce the deterioration of the first tape **51** due to the abrasion.

Likewise, when the paper sheet storage device **40** is used as the storage **32**, the portion of the second tape **52** near the second reel **54** is made thicker than the portion of the second tape **52** near the drum **55**, so that the portion of the second tape **52** with a relatively high frequency can be made thicker. This can improve durability of the portion of the second tape **52** used with a relatively high frequency against abrasion, and can reduce the deterioration of the second tape **52** due to the abrasion.

Sixth Modification of First and Second Tapes

As illustrated in FIG. **20**, both edge portions in the width direction of the first tape **51** may be thicker than the center portion in the width direction of the first tape **51**. Likewise, both edge portions in the width direction of the second tape **52** may be thicker than the center portion in the width direction of the second tape **52**. FIG. **20** illustrates a cross section taken along the width direction and the thickness direction of the first tape **51** (or the second tape **52**).

When regulating members are disposed at both sides in the width direction of the first tape **51** to regulate the shift of the traveling position of the first tape **51** (shift in the width direction), the edge portions in the width direction of the first tape **51** are worn by the regulating members. In such a case, the edge portions in the width direction of the first tape **51** are made thicker than the center portion in the width direction of the first tape **51**, so that portions of the first tape **51** which make contact with the regulating members can be made thicker. This can improve durability of the portions of the first tape **51** which make contact with the regulating members against abrasion.

Likewise, when regulating members (e.g., the regulating walls **76**) are disposed at both sides in the width direction of the second tape **52** to regulate the shift of the traveling position of the second tape **52** (shift in the width direction), the edge portions in the width direction of the second tape **52** are worn by the regulating members. In such a case, the edge portions in the width direction of the second tape **52** are made thicker than the center portion in the width direction of the second tape **52**, so that the portions of the second tape

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52 which make contact with the regulating members can be made thicker. This can improve durability of the portions of the second tape **52** which make contact with the regulating members against abrasion.

Other Modifications of First and Second Tapes

As described above, the first tape **51** may have a uniform (identical) thickness in the extension direction thereof, or may have a thickness that varies in the extension direction thereof. Likewise, the second tape **52** may have a uniform (identical) thickness in the extension direction thereof, or may have a thickness that varies in the extension direction thereof.

Further, the first tape **51** may have a uniform (identical) thickness in the width direction, or may have a thickness that varies in the width direction. Likewise, the second tape **52** may have a uniform (identical) thickness in the width direction, or may have a thickness that varies in the width direction.

The first tape **51** may have a portion used with a relatively high frequency thickened, or a portion making contact with the regulating member thickened. Likewise, the second tape **52** may have a portion used with a relatively high frequency thickened, or a portion making contact with the regulating member thickened.

Other Embodiments

In the above description, it has been described as an example the case where banknotes (an example of the paper sheets) are transported with their short edges coincide with the transport direction in the paper sheet handling machine **10** and the paper sheet storage device **40**. However, in the paper sheet handling machine **10** and the paper sheet storage device **40**, the banknotes may be transported with their long edges coincide with the transport direction.

Further, in the above description, it has been described as an example the case where the paper sheet handling machine **10** serves as a banknote handling machine that handles banknotes. However, the present disclosure is not limited thereto, and the paper sheet handling machine **10** may serve as, for example, a valuable medium handling machine that handles a valuable medium (an example of the paper sheet) such as a voucher and a check. Likewise, it has been described as an example the case where the paper sheet storage device **40** is configured to store and feed banknotes. However, the present disclosure is not limited thereto. For example, the paper sheet storage device **40** may be configured to store and feed the valuable medium (an example of the paper sheet) such as a voucher and a check.

The paper sheet may be principally made of paper, or a sheet-like medium principally made of resin.

The embodiments and modifications described above may be combined as appropriate. Note that the embodiments and modifications are essentially preferred examples and are not intended to limit the scope, applications, or use thereof.

As can be seen, the present disclosure is useful as a paper sheet storage device.

What is claimed is:

1. A paper sheet storage device performing a storage operation of storing a paper sheet sent into the device and a feeding operation of feeding the paper sheet, the paper sheet storage device comprising:

a first tape;
 a second tape;
 a first reel configured to wind the first tape from one end of the first tape;
 a second reel configured to wind the second tape from one end of the second tape; and
 a drum configured to wind the first tape and the second tape from other ends of the first tape and the second tape, wherein
 in the storage operation, the first tape and the second tape are wound around the drum with the paper sheet sandwiched therebetween to store the paper sheet, the first tape being positioned outside the paper sheet in a radial direction of the drum,
 in the feeding operation, the first tape is wound around the first reel and the second tape is wound around the second reel to feed the paper sheet from the drum, and
 in at least one of the storage operation or the feeding operation, greater tension acts on the first tape than on the second tape.

2. The paper sheet storage device of claim 1, further comprising:
 a torque controller configured to control a torque acting on the first reel and a torque acting on the second reel.

3. The paper sheet storage device of claim 2, wherein the torque controller includes a first torque limiter which regulates the torque acting on the first reel and a second torque limiter which regulates the torque acting on the second reel, and
 a maximum torque of the first reel regulated by the first torque limiter is greater than a maximum torque of the second reel regulated by the second torque limiter.

4. The paper sheet storage device of claim 2, further comprising:
 a first driver configured to rotationally drive the first reel; and
 a second driver configured to rotationally drive the second reel, wherein
 in at least one of the storage operation or the feeding operation, the torque controller controls the first driver and the second driver such that the torque acting on the first reel when the first driver rotationally drives the first reel is greater than the torque acting on the second reel when the second driver rotationally drives the second reel.

5. The paper sheet storage device of claim 1, wherein a winding diameter of the first tape on the first reel is smaller than a winding diameter of the second tape on the second reel.

6. The paper sheet storage device of claim 1, wherein the first tape is thicker than the second tape.

7. The paper sheet storage device of claim 1, wherein the first tape is wider than the second tape.

8. The paper sheet storage device of claim 1, wherein the first tape has higher rigidity than the second tape.

9. The paper sheet storage device of claim 1, wherein the first and second tapes are wound around the drum to overlap with each other in the radial direction of the drum.

10. The paper sheet storage device of claim 1, wherein the first and second tapes are wound around the drum not to overlap with each other in the radial direction of the drum.

11. A paper sheet handling machine comprising the paper sheet storage device of claim 1.

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